ON THE COVER

AFTER WINTER snows have partly melted and disappeared from mountainsides, the vestiges remaining in erosional depressions often take on meaningful configurations. Two of these manifestations are visible in Colorado each year and have religious significance. Best known is the Mount of the Holy Cross. The other one is the Angel of Shavano.

Legend has it that the angel, in punishment for her misdeeds, was sentenced by Jupiter to live on the side of Mt. Shavano until she should be moved to tears by the tragedies and sufferings of mankind. One year, when a drought threatened farm crops, she was overcome by sorrow and began to cry. As the tears flowed her body melted, and the water ran down onto the parched fields, making them green again. Then the angel was happy because she had saved her people. To this day the Angel of Shavano melts each spring to give life to the farm crops in the Arkansas Valley.

•

IN THIS ISSUE

IN TIMES long forgotten, ancient peoples discovered the art of working and shaping iron. No doubt it was some inquisitive metalworker who first found that two pieces could be joined by heating them and hammering them together. The world's first welder, he would be astonished if he could see the magnitude of the industry today. The story of its growth is told in our first article.

•

AN INADEQUATE and unintegrated railway system has been one of the main stumbling blocks in South America's economic development. The recent conflict served to emphasize that need. Several of the republics are now taking steps to improve their rail systems. The handicaps they face and how they plan to overcome them are described on pages 85-88.

•

POWER plants often produce electricity with diesel-engine generators because they operate economically and require little installation space. Furthermore, they can be assembled at the factory and shipped complete, ready for service. An account of the part played by such a unit in quickly restoring a burned-out power plant starts on page 89.

•

HOBBIES bring relaxation and relief from the daily grind to countless persons and sometimes develop into profitable businesses. On pages 92-93 we tell about a young veteran who has turned such a pastime into a paying proposition.

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C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Advertising Mgr.*
A. W. LOOMIS, *Assistant Editor* JOSEPH C. DILTS, *Advertising Sales*
WALTER P. GILLINGHAM, *Assistant Editor*
D. Y. MARSHALL, *Europe*, 243 Upper Thames St., London, E.C.4.
F. A. McLEAN, *Canada*, New Birks Building, Montreal, Quebec.

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The Story of Welding

W. P. Gillingham

PHOTO, BETTMANN ARCHIVE

SIR HUMPHREY DAVY

His discovery in 1801 of the electric arc led to the development of modern welding. A native of Cornwall, England, Davy showed no inclination towards science until he was apprenticed to a surgeon-apothecary at the age of 21, when he began experimenting with any apparatus that he could find. While on the staff of the Medical Pneumatic Institution at Bristol in 1799 he learned that nitrous oxide is respirable, reporting that he had become "absolutely intoxicated through breathing 16 quarts of it in seven minutes." His work there won him an appointment to the Royal Institution, where he was in charge of the laboratory and his assistant, for a time, was Michael Faraday. In 1815, Davy invented the miners' safety lamp that bears his name. He did not patent it, and in appreciation of his contribution the Newcastle coal-mine owners gave him a silver service in 1817. Under the terms of his will, the service was melted down and sold for about $3700 to endow a fund for a medal to be presented each year for the most important discovery in chemistry in Europe. Among the first to receive it was Robert W. von Bunsen, originator of the burner that is still used in chemical laboratories.

CREDIT for modern welding is generally given to Sir Humphrey Davy because his discovery of the electric arc in the first part of the nineteenth century led to the development of arc welding and to a new era in the art of joining metals. To most persons the term "welding" brings to mind the sputtering flame and bluish glare of the electric arc, for this young giant among the tools of industry has enjoyed such a phenomenal growth in the last three decades that it has overshadowed other processes. Yet arc welding is but one of many forms of welding which, itself, is so old that its roots are lost in antiquity.

The story of welding is man's quest through the ages for new ways of utilizing the earth's resources for his own betterment. One of the oldest-known facts about the working of iron is that parts softened and rendered plastic by heating in a fire will, under suitable conditions, unite or "weld." Because few implements of iron or steel survive the attack of rust for many years, there remains little direct evidence as to just when welding originated. The art of working and hardening steel, an advanced stage in metalworking that it doubtless took centuries to reach, was commonly practiced 30 centuries ago in Greece and is mentioned by Homer. It is probable that the principles of welding were discovered, lost, and rediscovered repeatedly by ancient peoples the world over, for it has been proved that primitive tribes on different continents and with no apparent means of communication developed and used the same basic methods of smelting, shaping, and treating iron.

By the time of the Renaissance, welding with fire had become an established practice and the craftsmen of that period were highly skilled in the work. The parts to be joined were properly shaped and then reheated to the right temperature in a forge or furnace before being hammered, rolled, or pressed together. Vannoccio Biringuccio's *Pyrotechnia*, published in Venice in 1540, contains several references to such operations. In one case, a square piece of steel was welded to the end of an iron rod for use in turning cannon bores. In another, cracked bells were made whole again by a method of welding. It is obvious that Biringuccio was intrigued by the latter application, for he wrote, "This seems to me an ingenious thing, little used, but of great usefulness."

For many centuries thereafter, ordinary fire remained the principle source of heat for welding purposes. The traveling tinker, a familiar figure on the dusty roads of many a countryside, carried with him a small charcoal furnace for heating his irons. Tinsmiths and other workers in metal often fanned the flames to greater intensity by means of bellows or used the heat of burning gases to braze and solder.

Forge welding of iron developed into an industry of considerable proportions, and until about 1890 was the only method available for welding this metal. Great skill and much labor were required in joining large, heavy pieces, for they could be heated sufficiently only by maintaining a fire around them. When the two parts had reached the proper temperature, they were forced together by various means, often being hung from cranes to facilitate the operation. Then the ends were struck repeated blows with a sledge hammer for a definite period, the heat being kept up meanwhile. That done, the work was withdrawn from the fire and finished on an anvil. Forge welding is still practiced to some extent today, mainly in railroad and country blacksmith shops.

In 1801, while experimenting with the infant science of electricity, Sir Humphrey Davy discovered that an arc could be created between two terminals of an electric circuit of comparatively high voltage by bringing them near each other. This arc, which cast a bright light and gave off a considerable amount of heat, could be struck and maintained at will, and its length and intensity could be

PHOTOS, BETTMANN ARCHIVE

BEGINNINGS OF WELDING

1– Long before the Christian era, blacksmiths joined metals by pounding them after they had been heated to a plastic state. 2– This apparatus, shown in Biringuccio's "Pyrotechnia" published in 1530, served to heat a cracked bell preparatory to forge-welding it. 3– An 1840 woodcut of a welding shop using lead and a hydrogen lamp for heating. 4– Elihu Thomson, American inventor, in the electrical workshop where he developed resistance welding, which was introduced in 1896.

varied within limits determined by the type of terminals utilized and by the circuit voltage. At that time it was regarded as a curiosity—there was no practical use for it. In fact, Sir Humphrey did not apply the name "arc" to his discovery until twenty years later.

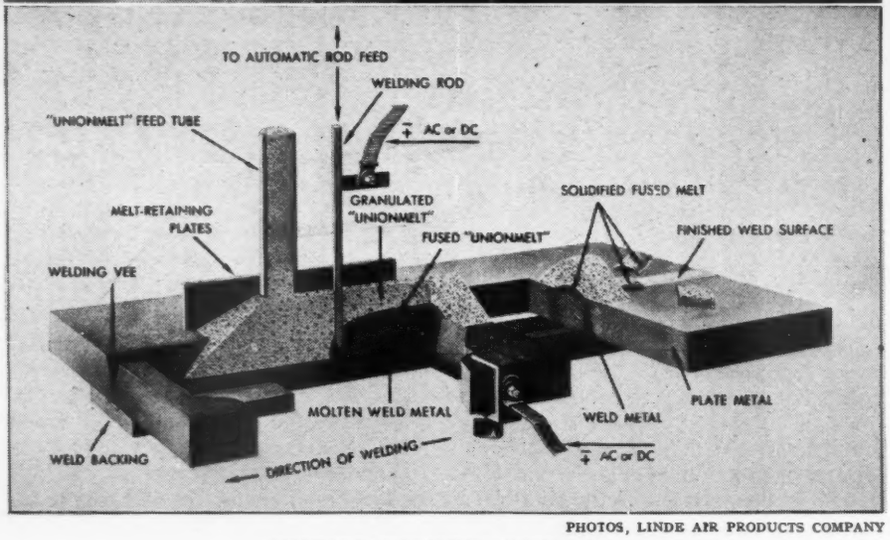
The electric arc remained a scientific plaything until 1881, when the well-known carbon-arc street lamp was introduced. Shortly thereafter the electric furnace made its appearance, one of the earliest being installed in 1886 at Milton Staffordshire by the Cowles Brothers for the production of aluminum alloys, the heat of a carbon arc serving to reduce alumina in the presence of iron or other metals. This particular application of the electric arc was an important step in the early history of the metal aluminum, for it disproved the belief, expressed by Lavoisier as far back as 1782, that the compound alumina could not be reduced by the element carbon.

Probably the first attempt to use the intense heat of the carbon arc for welding purposes was made in 1881 when De Meritens, an inventor, joined parts of a storage-battery plate by that process. In his experiment, he connected the work to the positive pole of a source of current and attached the carbon rod to the other pole in such a way that its distance from the plate could be controlled by the operator. The heat induced was partly lost in the surrounding air, but enough reached the plate to fuse the metallic lead and unite the several parts. In other early efforts with two carbon electrodes spaced as in an arc lamp and connected to a source of current, the heat of the resultant arc was deflected against the work by means of magnetic currents or a jet of compressed air.

Guided by these early experiments, M. V. Bernardos, a Russian scientist, reversed the procedure by connecting the work to the negative pole of a direct-current circuit and fastening the carbon rod to the positive pole, the arc being drawn between them. The rod was not fixed as in De Meritens's method, but was fitted with an insulated handle so that it could be manipulated by hand. This process, which was patented in 1887, had the disadvantage of introducing particles of carbon into the metal, making it hard and brittle. In the Slavienoff system, announced two years later, the carbon electrode was replaced by a metal rod which, upon striking an arc, gradually melted and added fused drops of metal to the weld.

Although the pioneer commercial application of arc welding in the United States is believed to have been made in 1910, its proponents were too far ahead of their time. The first motor-generator sets especially designed for arc welding were brought from Europe, where the process was in a more advanced stage. The sponsors of these machines induced a manufacturer to build them in this country, but the project was financially unsuccessful because the general public was not acquainted with arc welding and, consequently, skeptical as to the claims made for it. Further hindrances to its acceptance were the bulkiness and inflexibility of the existing equipment and the fact that no attempts were being made to develop suitable electrodes.

Arc welding received the needed impetus when emergency conditions during World War I brought it into the limelight. The U. S. Navy became interested when the method was successfully employed on interned German ships to salvage engines and other machinery that the crews had wrecked. All the welding during that period was done with hard metal rods of the fence-wire variety, so that the results, while spectacular in comparison with earlier ones, left much



PHOTOS, LINDE AIR PRODUCTS COMPANY

SUBMERGED-MELT WELDING

In this form of shielded-arc welding, a finely granulated material, which goes under the trade name Unionmelt, entirely submerges the tip of the welding rod, the arc, and the resultant weld (lower view). Even when brought to the temperature of the welding zone, the powder gives off only a minute amount of gas. It is a nonconductor of electricity when cold, but in the molten state will allow passage of sufficient current to make the weld. Fusion is started by placing a small wad of steel wool between the end of the welding rod and the work, then turning on the current. The heat generated melts the powder, which flows freely along the seam and forms a protective cover under which the welding operation takes place without sparks, spatter, fumes, or flash. The molten material forms a slag that floats on top of the base metal and insulates it from the atmosphere while it is cooling. Because of its nature in the fused state, the powder permits the use of high-current densities, with the resultant liberation of intense heat; and also because it concentrates the heat in a relatively small weld area, high welding speeds can be obtained with unusually deep penetration into the base metal. For these reasons the process lends itself to the automatic welding of heavy steel plate and was widely used during the war in shipyards for welding deck seams and for other fabricating work. The upper view shows a submerged-melt welding machine making a girth weld to join sections of 32-inch-diameter pipe for a natural-gas line. The pipe is rotated clockwise as operations proceed, and the Unionmelt is fed from an overhead hopper. A pneumatic collector serves to retrieve unfused granules and carries them to a storage bin for reuse, while a workman equipped with a hand tool removes the slag formed by the powder as it melts.

to be desired. Therefore, when coated electrodes were imported from Europe, they aroused considerable attention but did not at once attain widespread popularity. Though they did better work than bare wire, they were too expensive for ordinary use because the coating was applied by hand winding and dipping. Experiments conducted in this country with a view towards developing lower-cost methods were successful, and by 1930 facilities were available for the mass production of electrodes of this type. The U. S. Navy, which had contributed much to the growth of the struggling industry, then revised its specifications for welding machines from 25 to 40 volts in order to take full advantage of the shielded arc formed by the coated electrodes.

Another event that occurred about that time gave arc welding international publicity. By the Treaty of Versailles, the size of Germany's new ships was restricted to 10,000 tons. When she brought out the first in a line of "pocket battleships," which displaced only 10,000 tons but mounted guns of a caliber equal to that of much larger vessels, the world naturally sat up and took notice. By resorting to all-welded construction, the Germans were able to save weight and thus equip the craft with heavier armor and more guns without exceeding the over-all weight limit.

Aided by the aforementioned developments and encouraged by industry's need of rapid and economical methods of fabricating objects from metal, arc welding entered upon a period of growth that was truly remarkable. Its wide application gave birth to many new things and industries that otherwise might not have been created. Today there is hardly a plant in the country that does not use either arc welding or its products, and new applications for the process are continually being discovered. It is finding increasing usefulness in heavy construction work such as the erection of bridges and large buildings.

Although many of us are familiar with the method of arc welding, scientists are still trying to fathom the secret of the phenomenon of the electric arc. What it does is well known, for its temperature—with an estimated range from 6000 to 11,000°F.—brings the work to the melting point almost instantaneously, making possible deep, clean, and rapid welds. Electrodes may be composed of carbon, bare metal, or coated metal, but the latter type is used well-nigh universally.

Welding with the carbon electrode is a puddling process; that is, the arc serves to melt the work until there is a small puddle of molten metal which grows to a size sufficient to make the weld. Because of this, the method is not suitable for overhead welding, and its greatest application is in the field of automatic welding. It may be used with economy

OXYACETYLENE WELDING AND CUTTING

The combustion of acetylene gas and pure oxygen, which are thoroughly mixed at the blowpipe nozzle (left), produces a temperature that is estimated to reach up to 5400°F. Substitution of other gases for oxygen results in lower temperatures and, consequently, great flexibility that makes the process suitable for welding various metals. Fusion is usually, but not always, caused by flowing metal from a welding rod into the opening between the parts to be joined. In addition to welding, the oxyacetylene torch is widely used for the speedy cutting of metals (below).

PHOTOS, LINDE AIR PRODUCTS COMPANY

PHOTO, GENERAL ELECTRIC COMPANY

ATOMIC-HYDROGEN WELDING

Two tungsten electrodes are being used here to maintain an arc in the midst of a stream of hydrogen gas. Hydrogen is diatomic in its natural state, having two atoms in each molecule. When the gas passes through the arc, much of it is dissociated, and in so doing absorbs a considerable amount of energy. In striking the work to be welded, the atoms recombine into molecules and release their captive energy as heat. The temperature obtainable by this method is around 6000°F. and results in uniform, ductile, and unusually smooth welds. The picture shows a filler rod being held in the arc flame to provide metal for facing gear teeth.

as a cutting tool in dismantling assemblies. Overhead welding can be done by replacing the carbon electrode with a metallic rod, for in this case the transfer of metal from the rod to the work is not dependent upon gravity. Tiny globules of molten metal form on the tip of the electrode and are carried across the arc to the work by molecular attraction, adhesion, cohesion, or a combination of these forces.

In the ordinary arc struck with a metallic electrode, the globules which flow from the electrode, as well as the fused area of the work, are exposed to the atmosphere. Molten steel has an affinity for oxygen and nitrogen, both of which are found in abundance in the atmosphere, and will combine with them to form oxides and nitrides which weaken and embrittle the metal and lessen its resistance to corrosion. An ideal weld, one whose properties are equal to or better than those of the parts to be joined, cannot be made by arc welding unless the metal is protected from the harmful effects of the atmosphere during the entire operation from liquefaction to solidification.

In order to obtain a joint that is as nearly perfect as possible, most metallic arc welding is now done with what is called the "shielded" arc. The metal electrode has a chemical coating which disintegrates in the heat of the arc to create a cloud of protective gas that envelopes both the arc and the molten metal, shielding them from contact with the atmosphere. In addition to the gas, the coating forms a slag that floats on top of the molten weld metal and insulates it from the air while it is cooling. This slag, which is caused by the melting and reaction of the less-volatile mineral ingredients of the coating, also acts as a scavenger in that it removes oxides and other impurities from the metal, thus increasing its fluidity and helping to produce a better weld.

Since the coatings generally are poor conductors of electricity, the electrodes may be inserted into narrow grooves or other close quarters without danger of a short circuit by contact with the work. The coating also is an excellent medium for introducing alloying elements of different kinds into the weld metal to increase its tensile strength, hardness, and resistance to corrosion, or to give it other physical properties.

Commercial coatings usually contain compounds of substances such as silicon, barium, calcium, and magnesium. Metallic deoxidizers are sometimes added to get rid of small quantities of oxygen that may be in the weld metal, to control the amounts of the alloying elements, and to compensate for oxygen liberated from certain constituents in the coating. Water glass, a solution of sodium silicates, is commonly used as a binder, but

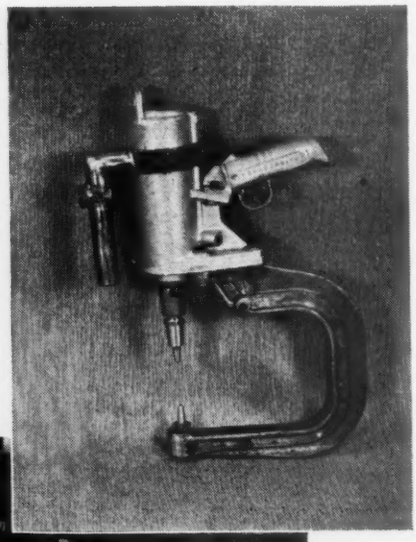
gums, glues, lacquers, etc., may be employed. Another advantage claimed for the coated electrode is that the covering burns at a slower rate than the metal core, thus forming a sheath that extends for a short distance beyond the metal and serves to confine the arc flame and to focus it upon the work.

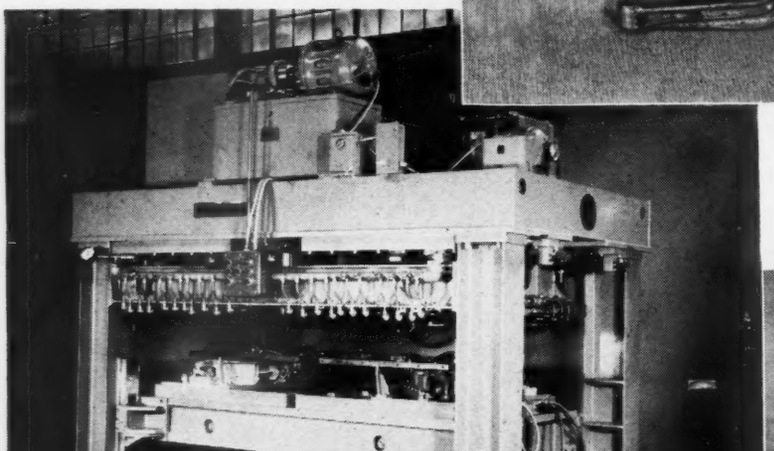
Another welding tool of more recent origin than the arc is the oxyacetylene torch which owes its origin to the discovery of a French chemist, Le Chatelier, in 1895. In a paper read before the Academie des Sciences, Le Chatelier disclosed that the combustion of acetylene with oxygen produces a flame having a temperature in the neighborhood of 6000°F., or far hotter than that of any other known gas flame. Well-nigh simultaneously with this discovery, work was being completed on two other processes that were destined to make possible the oxyacetylene-welding industry.

Acetylene is a colorless, combustible gas which forms an explosive mixture with air or oxygen. It is a product of the reaction between calcium carbide and water, the same on which the headlamps of early automobiles and present-day miners' carbide lamps are based. Calcium carbide was known as early as 1836, but was not produced commercially until 1892 when two men—Henri Moissan and T. L. Wilson, a Canadian electrical engineer—made it in Paris, France, and at an aluminum works near Leaksville, N. C., respectively, by heating a mixture of lime and anthracite in an electric furnace. In 1895, Dr. Carl von Linde of Germany placed a machine in operation for the manufacture of liquid air from which oxygen for industrial purposes is obtained. These two inventions—the use of the extremely high temperature of the electric furnace to produce calcium carbide, and the making of liquid oxygen at almost unbelievably low temperature—laid the foundation for the oxyacetylene process widely utilized today for joining, treating, and cutting metals.

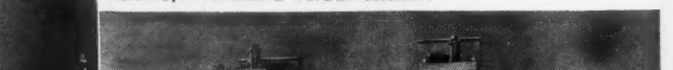
In the early stages of the method's development, many investigators experimented with blowpipes to control the oxyacetylene flame. That tool was by no means new to the metalworker, for a crude form of it had served ancient Egyptians, Greeks, and Romans in working metals possessing low melting points. In 1901, the first blowpipes capable of controlling the high temperature of the oxyacetylene flame were introduced by Fouche and Picard, with the result that the process was applied industrially by 1903.

By 1904, United States plants were turning out enough calcium carbide to meet the acetylene requirements of the nation. After much experimentation, a safe method of transporting the gas was devised. A porous material was packed tight in a steel cylinder and then saturated with acetone, a liquid having the property of dissolving many times its own volume of acetylene. Meanwhile, the oxygen supply in this country had been limited to the amount that could be produced by large-scale laboratory methods. In 1907, the first domestic





PHOTOS, PROGRESSIVE WELDER COMPANY



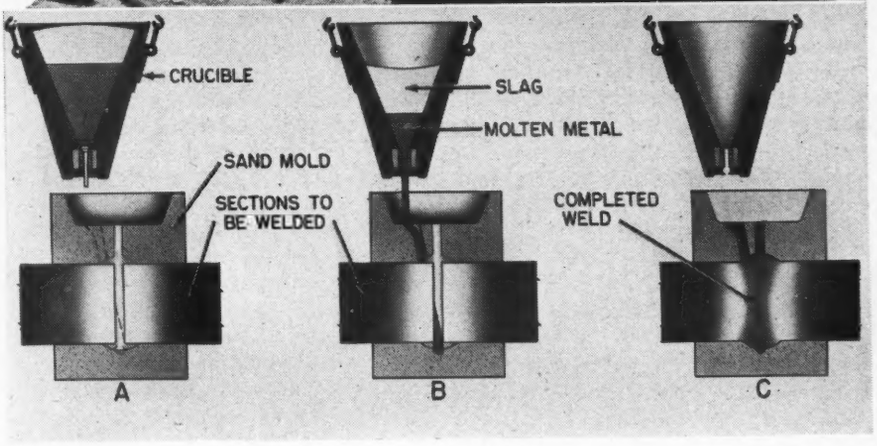
RESISTANCE WELDING

This process is principally used for joining relatively thin sections of metal by means of seams or numerous local welds. The welding areas are heated to a plastic state by passing an electric current through them and simultaneously exerting pressure to effect fusion. In the form of "spot" welding, it serves extensively in the mass production of various articles by means of special automatic machines. The view at the right shows a duplex seam welder designed for assembling stainless-steel trays for refrigerators. An air cylinder holds the electrode wheels on the work, while another moves the table on which the work rests. A multiple spot-welding machine that makes several dozen welds in rapid sequence on trailer door frames is pictured above. The table that carries the door is lifted into welding position by a 10-inch pneumatic cylinder acting through toggle linkage. Four other air cylinders bring the electrodes down in contact with the work. A portable spot-welding gun, with a built-in air cylinder that applies pressure to the electrodes, is illustrated at the top.

THERMIT WELDING

This process makes use of the intense heat generated by igniting a basic mixture of finely divided iron oxide and aluminum. The sequence of operations is shown at the bottom: A, the melting reaction, which is completed in about 30 seconds and takes place in an overhead crucible, produces molten metal and slag; B, upon tapping the crucible the contents flow into a prepared mold enclosing the parts to be joined; C, the result is a homogeneous weld. By adding varying amounts of carbon and manganese and occasionally nickel, chromium, vanadium, or other elements to the original mix, a wide range of alloys is obtainable. The view directly below shows a set-up for Thermit welding street-car rails. Equipment includes a crucible, a unit for preheating the rail ends on either side of the joint, tanks of oxygen and acetylene for use in cutting off metal risers left on the weld, tools for smoothing weld surfaces, and molds to be placed around the rail ends to receive the molten metal. A crucible discharging its molten mass into a mold is seen at the left.

PHOTOS, METAL AND THERMIT CORPORATION



plant for the manufacture of oxygen by the liquid-air process was placed in operation, and others followed rapidly as the demand increased. A few years before the outbreak of World War I, the distribution of oxygen and acetylene had become nationwide, and quantity production of welding and cutting blowpipes was underway.

Oxyacetylene welding possesses an advantage over arc welding in that it is extremely flexible. Although oxygen and acetylene are used well-nigh universally for the purpose, other combinations such as air and acetylene, oxygen and hydrogen, or oxygen and any other combustible gas are suitable. A mixture of air and acetylene serves where a lower-flame temperature is desired. The process usually necessitates the addition of a filler metal in the form of a rod held in the flame. Because the latter metal and the source of heat are separate from the work, better control can be exercised over the puddle. Protection of the molten metal from the atmosphere is provided by the enveloping flame. By applying a separate stream of oxygen, which is turned on after the work has been sufficiently heated, the oxyacetylene flame may be used for cutting.

Thermit welding was among the first of the new metal-joining processes to be developed. It is the invention of C. Vautin, who, in 1894, found that finely powdered aluminum mixed with metallic oxides, sulphides, and chlorides and then ignited would give a temperature of approximately 5000°F. and at the same time reduce the oxides to molten metal of a high degree of purity. Dr. Hans Goldschmidt of Essen, Germany, made a practical application of Vautin's discovery by using the molten metal produced by the reaction to weld together two iron bars. He also devised a safe method of igniting the mixture, on which he was granted a patent in 1897.

Welding by the Thermit process involves pouring superheated liquid steel around the parts to be united. Thermit, a mixture of iron oxide and metallic aluminum, is placed in a refractory-lined crucible and lighted with the aid of a highly inflammable powder composed largely of barium peroxide. During the resultant reaction, which is completed in about 30 seconds, the aluminum combines with the oxygen of the iron oxide

AIR-OPERATED TOOLS

Pneumatic tools are a necessary part of welding equipment. Most welders have, close at hand, a scaling hammer for use in cleaning welds and in removing slag and excess spatter (left). A chipping hammer (center) is an essential tool in preparing the welding Vee between two pieces of metal to be joined, in getting rid of unfused metal from the reverse side of an initial weld before starting the backing weld, and in removing excess weld metal flush with the surface. Portable grinders, equipped with either a wire brush or an abrasive wheel, serve to smooth the rough surfaces of welds and to get them ready for painting (right). Air-operated hoists are frequently utilized to expedite the handling of work, especially where heavy pieces are welded on a production-line scale.

to produce a slag, leaving pure molten iron. Elements such as carbon, manganese, silicon, sulphur, and phosphorus are usually added to convert the iron into a steel possessing physical properties similar to those of forged steel. Following the reaction, the molten Thermit steel is tapped into a sand-filled mold surrounding the parts to be joined. Since the metal is approximately twice as hot as ordinary molten steel, it fuses and welds the pieces into a single, homogeneous part. To prevent chilling of the steel, the work is heated before the molten metal is poured into the mold

The Thermit process is especially applicable to the welding of large sections and to the repair of heavy parts such as locomotive frames, rudders and stemposts of ships, crankshafts, railroad rails, spokes of driving wheels, motor casings, and connecting rods. One of its great advantages is that broken pieces can generally be welded without a change in position. The method is also used extensively in welding pipes, but in that case the technique differs slightly from that just described. Because the metal would fill up the pipe openings if it were allowed to come in direct contact with the piping, the crucible is decanted so that the slag enters the mold first, coating the outside of the pipes and the inside of the mold. When the liquid steel flows into the mold, it heats the ends of the pipes but is prevented from fusing with the metal by the slag coating. The sections are then forced together to form the weld.

With resistance welding, developed in 1896, Elihu Thomson gave industry a method that is not only simpler and less expensive than previous ones but that is applicable to a wider range of metals. An American inventor, Thomson was particularly active in the field of electricity, holding more than 700 patents and being one of the founders of the General Electric Company. His process is based on the fact that the resistance offered by a metal object to the passage of an electric current will generate heat within that object. Therefore, when two pieces of metal are brought in contact and current is passed through them they will be heated sufficiently to weld when pressed together. The acceptance of resistance welding by industry was immediate, one of its earliest uses being the welding of metal tires for wooden wagon and buggy wheels.

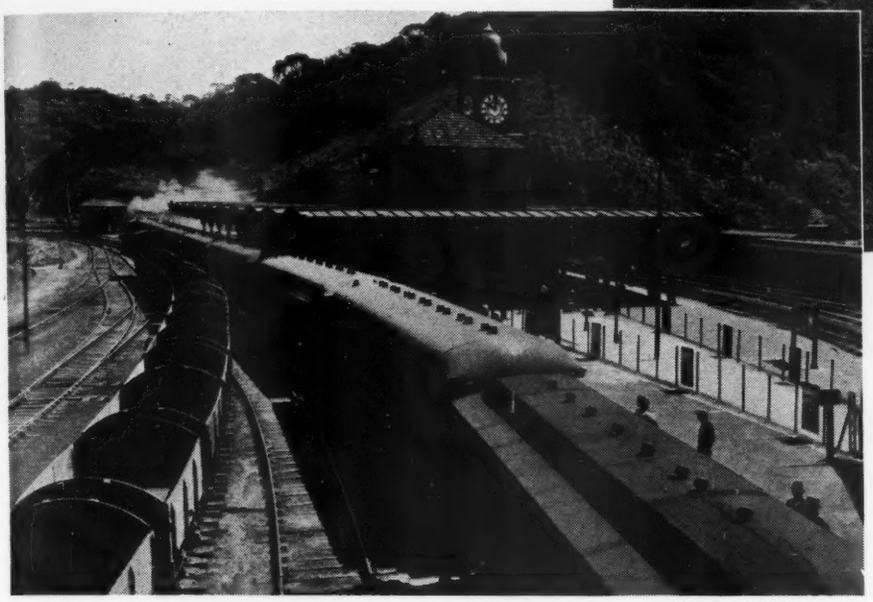
The process differs from others principally in that no foreign material is introduced into the weld. Metal parts that it would be difficult to bind together by other methods are easily resistance-welded, examples being fine wires or thin sheets. Ferrous and nonferrous alloys are welded with equal ease, and even totally different materials such as copper and steel can be joined. Because the process lends itself readily to automatic control, it is especially applicable to modern mass-production methods. It has a wide field of service in the manufacture of all kinds of products such as the household refrigerator, which has more than 3000 spot welds. Another large user of resistance welding is the automobile industry where, in addition to other types of welding, it finds large-scale application in fashioning automobile bodies.

Compressed air plays a vital part in welding. This applies especially to arc welding that calls for the services of literally thousands of air-operated tools in the fabrication of all sorts of metal objects. Pneumatic chipping hammers prepare the V-cut required in joining metal plates; gouge out unfused metal from the reverse side of a weld preparatory to making a backing weld; and remove excess metal from the surface of a finished weld. Air-operated grinders and scale removers help to clean and smooth welds for painting. Large welded objects are sometimes cleaned by exposing them to a blast of sand and compressed air. In arc welding cast iron, a jet of compressed air is directed upon the finished weld after it has been allowed to cool for a few seconds. By thus hastening cooling, the over-all welding time is reduced, it is claimed, by at least 25 percent.

Automatic welding machines are equipped with power cylinders largely of the pneumatic type that may be controlled by foot pedal to leave the operator's hands free for other tasks. These cylinders are used for a variety of purposes, one of them being the lowering and raising of the entire welding head of an automatic arc-type unit to permit placing and removal of the work. Many resistance-welding machines have such cylinders to clamp and hold the parts to be joined, while air-operated tables permit the continuous welding of long pieces or sheets of metal.

South America's Railroads Eye the Future

*Seymour T. R. Abt**



EWING GALLOWAY PHOTOS

SAO PAULO RAILWAY

A 10-year railroad rehabilitation plan, calling for expenditures of nearly half a billion dollars, was initiated by Brazil in 1946 but is not proceeding at the scheduled pace. The principal need is for continuous lines running north and south. One of Brazil's best railways is the Sao Paulo system extending into the interior from Sao Paulo. It was financed largely with revenue from the coffee industry. The road climbs 3000 feet in 25 miles, reaching its highest point at Alto da Serra. The station located there is pictured directly above. The other view shows a passenger train on the line.

SOUTH AMERICA'S railways are far from adequate to meet the demands of the continent's economy. Lines are run down, equipment is antiquated, and many areas are untapped by either rails or modern motor highways. Yet no one is more aware of their railways' shortcomings than the South Americans themselves.

Probably not until the recent conflict, when the Allies badly needed the continent's hidden wealth of precious raw materials, did South America realize its own economic strength. At the same time, exports of transportation equipment and other goods from the United States, Canada, and western Europe virtually ceased. The war made it clear, perhaps more than ever before, that South America would remain largely undeveloped so long as transport facilities were inadequate. Today there are fertile agricultural lands that are not worked because their produce cannot be moved to consuming centers. Mines cannot get their ores to smelters or to the seaboard for export. Valuable timber stands untouched in inaccessible forests. Pack trails are the only contact between countless isolated communities and western civilization.

Factors that have impeded the development of a continental rail network are too many and too complex for more than mere mention here. Enervating temperatures, torrential rains, rugged topography, disease-ridden swamps, and a lack of indigenous coal are among the natural difficulties. Many lines were originally built with foreign capital for private interests and without thought of eventual connection with other roads. There is no uniformity in gauge, virtually no railway-equipment industry. The competing motor highways were born before railroads had attained maturity.

A survey of recent railway expansion reveals definite trends. Foremost among these is a move towards nationalization. Though Argentina, which has nationalized substantially its entire system, is the outstanding example, there is not a republic in South America without some state ownership of railroads. The general feeling seems to be that the only way to make them function in the public interest is to bring them under government ownership. Private lines, especially those under foreign control, are rapidly losing out.

There is an emerging pattern of international railways. Advocates of hemispheric solidarity can find no more heartening development than this desire of neighboring countries to connect by rail. The transcontinental line from Santos, Brazil, to Arica, Chile, is foremost among these projects, but there are other significant ones.

Within national boundaries there is a determination to round out fragmentary networks. This is a slow and expensive procedure. Many railways are isolated and not part of any system. The stated objective of many governments, however, is the integration of such roads into coherent networks. Among these nations are Brazil, Colombia, and Venezuela.

Important as these trends are, South America's primary consideration is the rehabilitation of existing lines. The tremendous traffic increases of the war years, coupled with neglected maintenance through lack of imports, have created intolerable conditions in many areas. Deterioration of roadbeds and rolling stock is apparent everywhere. Most current railroad expenditures are allocated to repair and replacement of facilities rather than to expansion. The larger plans, vital as they are, are of secondary import.

Argentina has virtually finished taking over British- and French-owned railways, which accounted for nearly 70 percent of the total mileage. Their acquisition was one phase of a nationalistic policy to make Argentina a leading power in world economy. The Five-Year Plan for the period 1947-51 includes a tentative railroad program calling for the completion of a few lines now underway, the initiation of one or two new projects,

*Transportation and Communications Division, Office of International Trade, U. S. Department of Commerce.

and the purchase and modernization of equipment.

The existing network fans out of Buenos Aires and long since reached the country's main production and population centers. Revitalization of the system is more important to Argentina than new construction. The Five-Year Plan involves an outlay of about $195,000,000, most of which will probably be spent in purchasing badly needed rolling stock and bringing existing equipment up to date. The requirements, following eight years of deferred maintenance, are huge. In December, 1946, the government called for bids on 350 freight cars, and in the succeeding month placed orders for 210 diesel-electric locomotives. In July, 1947, bids were asked on 2500 railway cars, as well as on radio devices for car-to-car and car-to-station communication. Reports from various sources indicate that considerable additional equipment has been bought, ordered, or sought in recent months.

It is generally recognized that Brazil's inadequate transportation system is blocking full economic development of that country. Its vast area demands efficient railways, and Brazilians have long been acutely conscious of this need. In January, 1946, the Brazilian Government announced a $490,000,000 Ten-Year Plan of railroad rehabilitation. The Director of the National Department of Railways indicated that credits would be sought from the United States for the eventual purchase of 17,508 railway cars, 974 locomotives, the reëquipment of repair shops, rail renewals for 8615 miles of track, and the construction of 9615 miles of permanent way. It is difficult to estimate how much of this program will ever advance beyond the paper stage, but signs are not encouraging. Credits actually authorized by the Export-Import Bank during 1946 and the first half of 1947 total only $20,735,521.

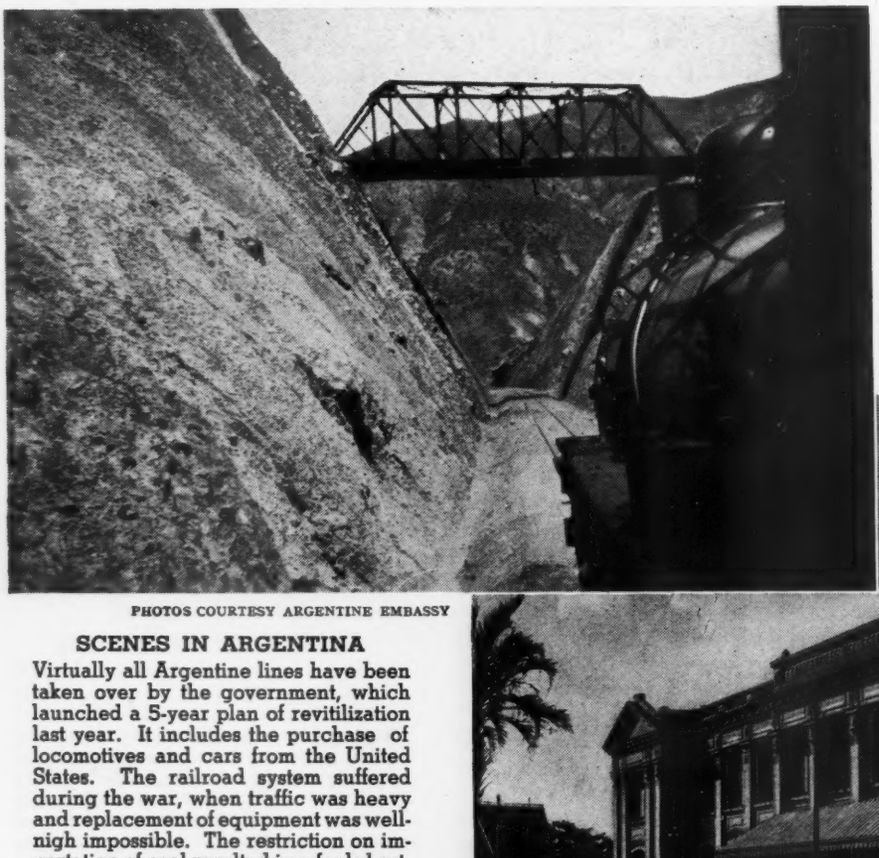
Brazil's major railroad project is designed to give continuous, meter-gauge transportation from north to south within a relatively few miles of the seaboard. Lines running inland from various seaports dot the coastal region. However, except for those in the vicinity of Rio de Janeiro and Sao Paulo, most of them do not penetrate far inland and are not connected with other railways.

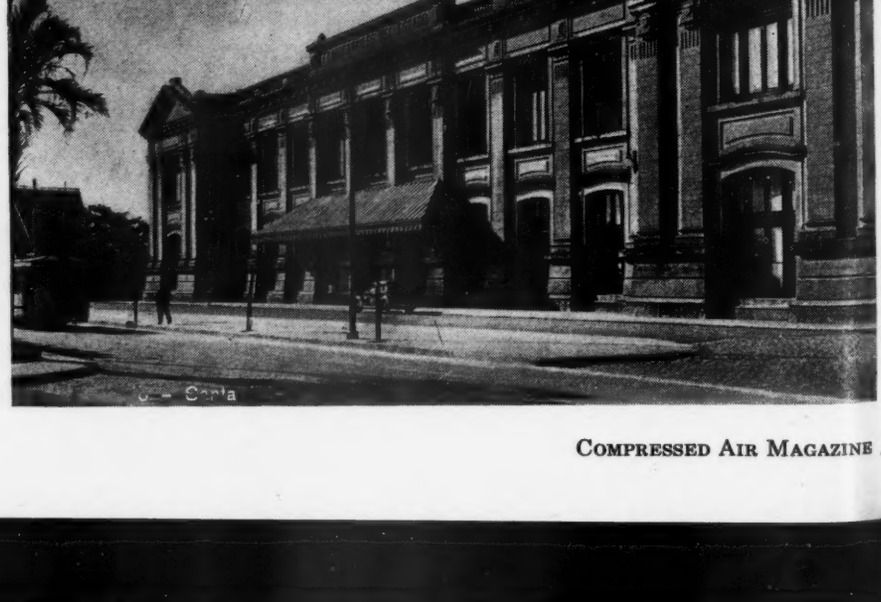
Other plans to improve or speed up the republic's rail service have been made or acted upon. Several systems have ordered new equipment in the United States, or are seeking credits for such purchases. Six of them have appropriated close to $750,000 for that purpose in the 1947 federal budget, the largest sum being $213,600 for machinery for the Curitiba shops of the Parana-Santa Catarina Railroad. In addition, $240,300 has been earmarked for rolling stock and for equipment needed in the building of passenger and "open cars" by the Braganca Railway.

Perhaps the most publicized of all the Brazilian rail projects is one that is being carried out in a neighboring country. This line extends from the Brazilian border across the little-known eastern part of Bolivia to Santa Cruz. The 1947 budget allocated $2,563,000 for the work which, when concluded, will provide through service between Santos and Arica. As this road is already operating between Santos and a point close to the Bolivian boundary, little new construction is necessary on Brazilian soil.

Completion of the Bolivian section of the line is still many years away. Its backers hope that it will foster trade between Bolivia and Brazil, afford a new sea outlet for Bolivia's mineral exports via the port of Santos, and facilitate the colonization, exploration, and development of the vast reaches east of the Antiplano. The last consideration is of primary importance to both countries because the region that would be served by the railway is believed to be rich in oil. Bolivia needs this oil, especially as an export commodity. Brazil, without oil of its own and with only inferior coal deposits, is promoting exploitation of the petroleum lands. In accordance with a 1938 treaty, it is financing the railroad project in Bolivia under the supervision of a Mixed Bolivian-Brazilian Commission.

The new line is slowly but definitely inching westward. A section of 187 miles was opened in January, 1947, marking





PHOTOS COURTESY ARGENTINE EMBASSY

SCENES IN ARGENTINA

Virtually all Argentine lines have been taken over by the government, which launched a 5-year plan of revitilization last year. It includes the purchase of locomotives and cars from the United States. The railroad system suffered during the war, when traffic was heavy and replacement of equipment was well-nigh impossible. The restriction on importation of coal resulted in a fuel shortage, and large quantities of wood, oil-bearing seeds, and corn were burned under locomotive boilers. Above is shown a deep cut on the route to Bolivia, with a locomotive partly visible. The station in the city of Santa Fe is pictured at the right.

COLOMBIA STRUCTURES

The chief railroad problem in Colombia is that of linking the scattered lines into a unified system. A long-range plan for this purpose was entered upon in 1945 with the hope of attaining the objective in six years. A railway bridge over the Magdalena River is shown at the left and, below, an interior view of the car shops at Cali.

DEPARTMENT OF COMMERCE PHOTOS

completion of the stretch from Corumba on the Brazilian border to El Porton, almost half the distance to Santa Cruz. This section took eight years to build and cost approximately $14,000,000. Penetration farther westward will not be a simple matter. Construction materials will have to be carried far, and the swampy terrain will make operations difficult. Nevertheless, some optimistic forecasters predict that the road will reach Santa Cruz by 1949-1950.

West of Santa Cruz, another stretch of 316 miles to Vila Vila remains to be built in order to complete the transcontinental route. Bolivia has undertaken this work, thus far without Brazilian participation. To date, the Bolivian Railroad Administration has constructed about 6 miles, including a 177-foot bridge. A Bolivian firm has finished, under contract, an additional 19-mile section exclusive of a 2559-foot tunnel, of which 755 feet still has to be driven. Beyond that, a 12-mile stretch to Mizque is being built by the Railroad Administration, but headway has been made on only 3 miles. Some work has been started east of Mizque. But as yet, none of the roadway beyond Vila Vila has tracks. Completion of the line is outlined in a 5-year plan, the success of which is contingent upon the availability of funds. The total cost from Vila Vila to Santa Cruz is estimated at $35,000,000, including $2,500,000 for rolling stock. Although Brazil is committed by treaty to help finance the project, Argentina may in the end assume that burden.

Present-day railway development in Chile has for its main objectives the completion of international lines to Argentina, the extension of branches to areas not yet served, and the improvement of various State Railway systems. Less pressing plans call for further rail electrification.

Two transandean lines have long been under construction by the Chilean Railroad Department. In the Province of Antofogasta, work is progressing on a 112-mile stretch between Augusta Victoria and Socompa, on the border of Argentina. This road, which will connect with the Argentine network, has great potentialities. It is expected to provide for the exchange of commodities vital to both nations—Chilean nitrates and minerals moving to northern Argentina, and Argentine foodstuffs, cattle, and forest products to northern Chile. It will also give Argentina access to a Pacific port through which its foreign trade may flow, aided by a comparatively short rail haul.

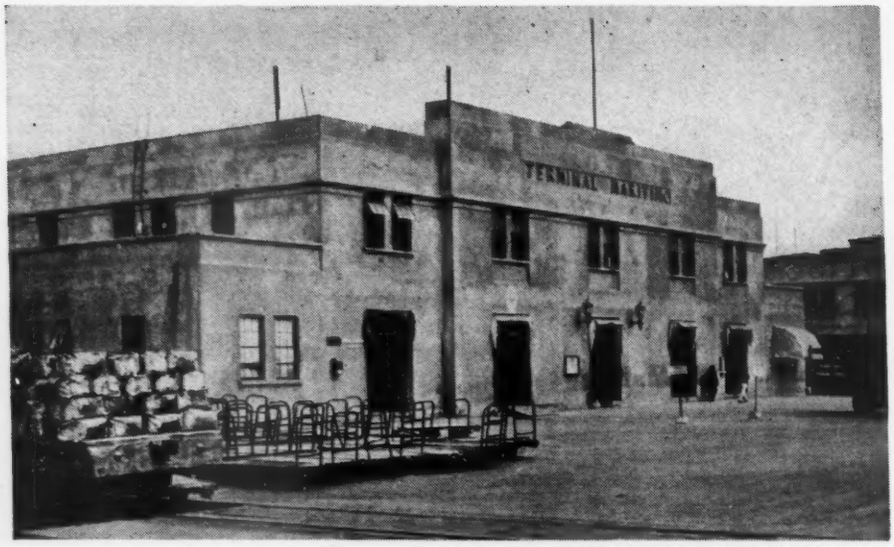
The second international system is the Transandine Railway in the Province of Malleco. There construction is underway between Curacautin, to which the line now extends, and Lonquimay, a distance of about 40 miles. As in the case of the northern route, it will tie in with the Argentine system and facilitate the interchange of materials between the southern sections of the two countries, which now requires a long rail or water haul. A sum of $129,000 was allocated in 1947 for the continuation of this project.

In addition to the work on these trunk lines, Chile is building branch lines or improving existing ones that will stimulate both trade and tourist travel. To further the program, the State Railways in October, 1946, obtained authorization for a $5,000,000 credit from the Export-Import Bank of Washington, the money to be spent in the United States for diesel-electric locomotives, motorcars, components for freight and passenger cars, bridge materials, rails, repair-shop machinery, and other equipment.

Uruguay's one important current undertaking is the extension toward the Brazilian border of the State Railway which runs from Florida to Blanquillo. Thirty of the 43 miles are under construction, including a bridge over the Rio Negro. Uruguayan officials believe that this road is destined to open up one of the most fertile and productive regions in the country. Cattle and sheep are abundant there, and the land produces wheat, corn, oats, linseed, potatoes, and other crops.

None of Paraguay's ten railroads have scheduled other than normal maintenance. A new line to connect with the Brazilian system extending from Santos has been discussed for several years. Some work is reported to have been done on the Brazilian side of the border, but none in Paraguay, and the future of the entire project is in doubt.

Of outstanding importance to both Peru and neighboring Bolivia is the line being built from Matarani to La Joya on the Southern Railway of Peru. Matarani is a new port completed in 1941, and is designed to replace Mollendo, about 9 miles to the north, as a place of entry for southern Peru and the Bolivian highlands. Lack of rail service has limited Matarani's usefulness, whereas Mollendo is the ocean terminal of the Southern



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TERMINAL AT CALLAO, PERU

One of Peru's leading railway projects is the development of adequate connections with Matarani, a new port completed in 1941 that is designed to replace Mollendo. The picture shows the administration office at the Callao terminal.

Railway. Need of the new link is a pressing one for land-locked Bolivia, which now depends on foreign ports that are inadequate to handle the traffic. The Matarani-La Joya line, 39 miles long and more than half finished, is being constructed by the Peruvian Government. Tracks are laid for approximately 18 miles at the La Joya end. Progress is slow, but some authorities expect completion by the end of 1948.

One other undertaking in Peru is worthy of mention: the Yauricocha extension from the Central Railway. The work is being done by the Cerro de Pasco Copper Corporation which owns copper mines at Yauricocha. The prospects are that the road, as well as an aerial tramway over the same route, will be ready for use early this year.

Indications are that Ecuador will concentrate in the immediate future on one major project—the completion of the Quito-Ibarra-San Lorenzo railroad. Its present northern terminal is Salinas, just northwest of Ibarra, and construction at different points beyond Salinas is progressing. The work was allotted about $740,000 in 1947. San Lorenzo is a deep-water harbor about 15 miles from the Pacific Ocean. Although a channel will have to be dredged through the sand shoals for sea-going vessels, authorities are of the opinion that frequent use and tidal action will keep this passage clear. The new line will give Quito a route to the ocean that will be approximately 47 miles shorter than the one to Guayaquil, and Lorenzo has the added advantage of being 500 miles closer to the Panama Canal.

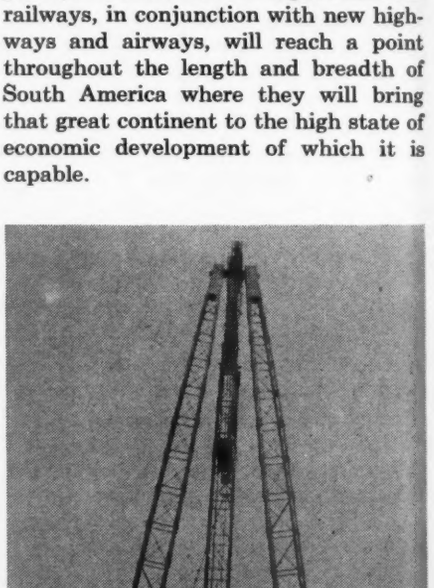
As in the case of Brazil, Colombia's primary railway problem is that of linking its scattered roads into a unified system. North-south lines are at present built around the Magdalena River, with many highways and railroads acting as feeders. Land transport on both sides of the stream consists of rail routes connected by highways supplemented by aerial cableways and primitive animal trails. To overcome the limitations of these facilities, the Colombian authorities are intent upon welding the rails into a coherent structure.

A long-range plan, embodied in a 1945 law, outlined a program and created a National Railway Fund exclusively for the construction and equipment of the Ibague-Armania, the Main Occidental, and the Main Oriental railroads. United States experts have estimated that the over-all project will require more than six years for completion. The Ibague-Armania System, which is 85 miles long, will close the only gap that now interrupts continuous rail service between Bogota and the port of Buenaventura. The Main Occidental is to extend from Cartagena on the Caribbean to Tumaco, a Pacific port in southernmost Colombia, while the Main Oriental is to be a trunk line east of the Magdalena River and will connect Bogota by rail with the Caribbean Sea.

Venezuela is the third South American republic seriously concerned with unifying its separate rail lines. On January 29, 1946, the government established a State Railways Administration to administer its four common-carrier roads and to analyze their conditions. It was also charged with the responsibility of studying methods by which to rehabilitate the lines and integrate them into a national network. In December, 1946, about $140,000 was appropriated for operating and improving the railroads and for the purchase of additional equipment.

Proceeding with its assignment, the new agency last year entered the market for rolling stock and repair parts and has been working to improve tracks, shops, stations, and other structures. It has also made efforts to expedite the movement of freight on government-owned lines. It should be pointed out, however, that railroad transportation in Venezuela has deteriorated in recent years. Highways have been gaining in importance, while railways have fallen into a serious state of disrepair. A recent study by the National Highways Commission indicates that new motor roads will be built in regions where such traffic arteries seem to be more desirable, even temporarily, than railways. Where both are deemed necessary, the latter will probably receive priority.

From the foregoing review it is clear that decades will elapse before South America will, if ever, have a railroad network comparable to that of the United States or Western Europe. It is equally clear, however, that even slight improvements in existing facilities will open up vast areas of potential wealth that are today virtually inaccessible because of a lack of modern means of transportation. Given a prolonged period of world peace, it is reasonable to expect that the railways, in conjunction with new highways and airways, will reach a point throughout the length and breadth of South America where they will bring that great continent to the high state of economic development of which it is capable.



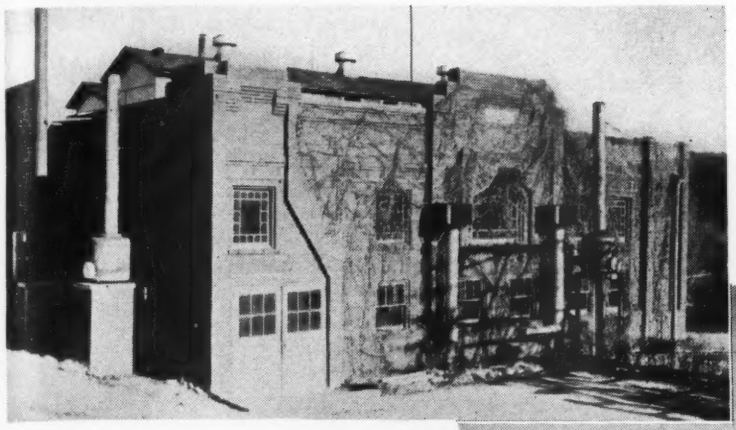
DEPARTMENT OF COMMERCE PHOTO

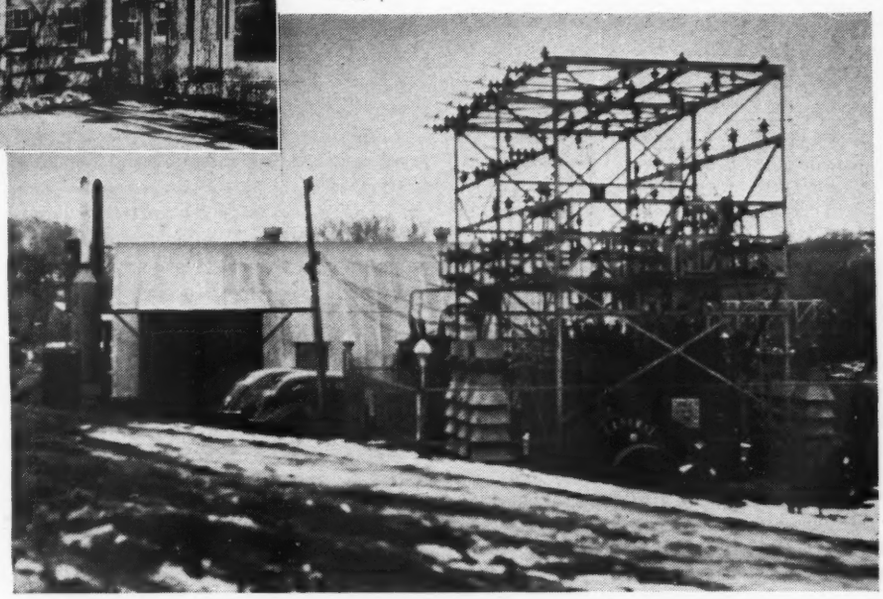
DERRICK LIFTING A CAR

A 30-ton load being shifted at a siding in Rio de Janeiro, Brazil.

Burned-Out Power Plant Speedily Restored

Spencer, Iowa, Utility Resumes Service with Three Diesel-Engine Generators 125 Days After Disaster





BEFORE AND AFTER

At the top is the Peterson power plant as it appeared before the fire. To get it back into service as quickly as possible, quonset-type buildings were constructed to serve until more substantial housings can be erected. The lower view shows the larger of the two provisional structures, with the substation in the foreground.

IOWANS are accustomed to warm weather in June. They even like it, because it makes the corn grow, and Iowa's economical well-being hinges largely on its corn crop. Sunday, June 22, 1947, was a typical summer day in northwestern Iowa—warm and sultry, with not much air stirring. At the close of that day, people in the town of Peterson, Clay County, and in the surrounding farming area were sitting on their porches exchanging small talk or perhaps making plans for the next day's tasks. The men were in shirtsleeves, the women in cotton dresses. It was the longest day of the year, much daylight remaining after the evening meal had been eaten and the dishes washed and put away.

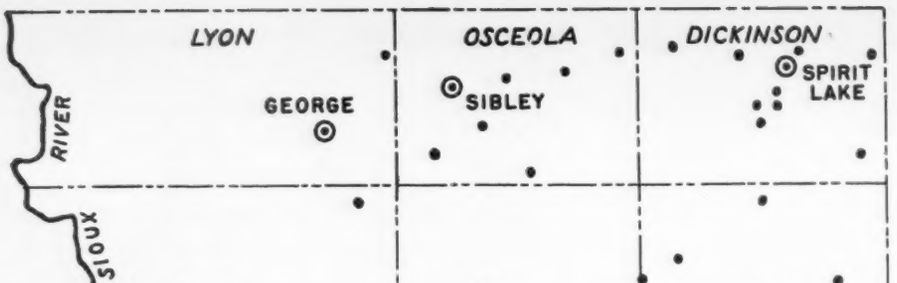
It was much like any other June Sunday; a somewhat lazy and restful day that had come as a welcome break in the weekday routine. Oldsters had indulged in the luxury of lolling in bed an extra hour or so, and they had done only such work as was necessary. Now, with night approaching, they were relaxing. Occasionally they glanced at the sky, for it was apparent that storm clouds were gathering. Rain, always welcome in farm country, was unquestionably on its way.

The storm broke around 7:30, and was accompanied by severe electrical effects. Half an hour later the Peterson generating station of the Northwestern Power & Light Company was on fire. It was assumed that a bolt of lightning was the cause, although there was no direct evidence that this was the case. At 8:23, electric clocks stopped in Peterson and in the neighboring countryside. Firemen from Peterson and nearby Sutherland fought the blaze without success because the flames had either started in or reached 1000 gallons of oil stored in the basement to fuel the diesel engines that operated the generators. Water could not be used because of the danger of electrocution, and in a few hours the building and its equipment had been destroyed, with a loss of around $450,000.

In addition to Peterson, the plant served the towns of Moneta, Linn Grove, Sioux Rapids, Marathon, Everly, and Royal, as well as the intervening farming areas. The stricken station was one of four interconnected sources of power in the Northwestern Light & Power Company's system, which supplied an L-shaped section in six counties located northeast of Sioux City. Peterson is at the south end of the territory. Other company generating plants are at Spirit Lake, Sibley, and George. Sufficient power was available from these sources partly to restore normal service in the zone affected by the fire. The current required to make up the shortage was obtained through existing tie-ins with the lines of other utilities at Albert City, Peterson, and Emmetsburg, all at the southern end of the "L." The Sibley and George stations, which normally run sixteen or seventeen hours daily, were stepped up to 24-hour operation until the Peterson plant could resume full service.

Because of these interchange agreements, which are typical of the measures regularly taken by American power companies to protect their customers, the fire occasioned no serious interruption in service All consumers in the region involved, except those in Peterson and its immediate vicinity, had current within three hours after the outage. In the case of Peterson there was a longer delay, because the automatic switching equipment was inside the building. This necessitated some rewiring outside so that switching could be done manually. The essential facilities were set up in a few hours, and service in the Peterson area was restored at 2:30 the following morning.

Coming as it did on a Sunday, the fire caused a minimum of inconvenience and discomfort to the utility's customers. Power was available as usual on Monday morning when the business, farming, and domestic activities began anew. Most electrically operated industrial equipment had been shut down over the week end, so interruption in this connection was inconsequential. In homes and on farms the break in continuity, though noticeable, was of such short duration that there was little monetary loss and no hardship. So far as the public was concerned, then, the fire had little effect, thanks to the foresight of the North-



NORTHWESTERN'S TERRITORY

The company has 8000 customers of which 6900 are in 35 towns (shown by dots) and 1100 on interlying farms. From the four generating stations, which are indicated by the circled dots, 609 miles of transmission lines extend into six counties.

western management in providing safeguards in the form of interchange agreements with concerns having interconnecting power networks.

From a company standpoint, the fire was, of course, more serious. Its customers were being taken care of, to be sure, but this imposed a burden upon other facilities that could not be carried indefinitely. It was important that the Peterson plant be rebuilt, reëquipped, and restored to service as soon as practicable. Plans were immediately put in motion to bring this about. Fortunately, diesel-engine generating units are essentially packaged machines that are assembled at the factory and shipped virtually intact, making it possible quickly to put them in place, ready to operate. True, they can't be bought off the shelf like hardware, but manufacturing schedules under our industrial system are such that relatively fast deliveries can be made in circumstances such as existed at Peterson. Actually, one new 600-hp. engine-generator set was "on the line" in 38 days, and complete equipment, consisting of three units aggregating 3240 hp., was installed and running on October 25, a trifle more than four months after the fire.

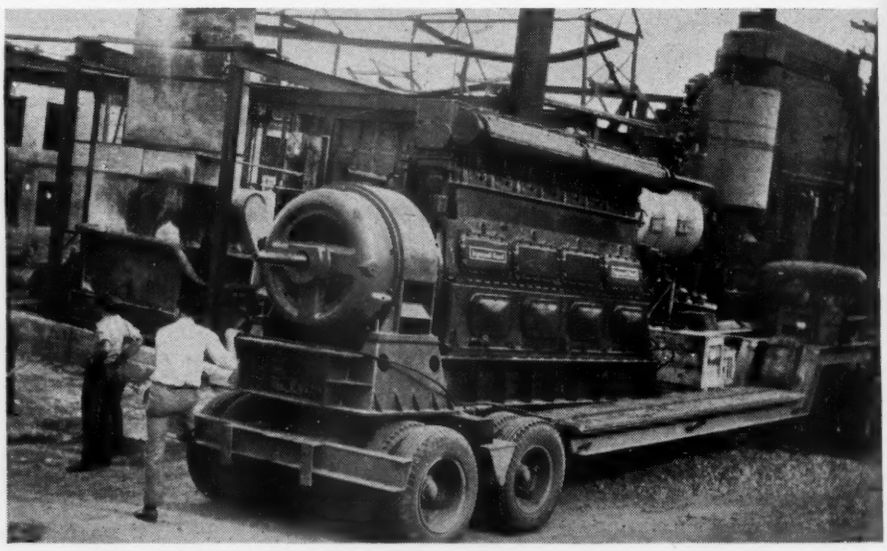
The territory in which Northwestern Light & Power Company operates is predominately rural. Agriculturally it is classified as the cash-grain area of Iowa. Unlike other sections of the state, a larger proportion of its farmland is in cultivated crops such as corn and small grains and a smaller one in pasture. Livestock, with the exception of sheep, is less numerous than in other parts of Iowa. The two largest towns of the 35 served by the Northwestern system, Sibley and Spirit Lake, have populations of 2356 and 2161, respectively, according to the 1940 census, and all but two of the others have fewer than 1000 inhabitants.

Of the company's 8000 customers, 6900 are classified as urban and 1100 as living on farms. Urban-household and retail-business consumption in this area is typical of that in most other parts of the United States. Farms use electricity for lighting and to control automatic heating and home appliances. Outside of the house, electric power operates a variety of equipment, including milking machines, chicken and pig brooders, water pumps, barn ventilating fans, hay and feed hoists, blowers and grinders, welders and farm-shop tools.

Among Northwestern's customers are twenty feed-grinding establishments and five small manufacturing concerns. The latter, listed as 150-kw. users, make a variety of products such as tank heaters, grease guns, covers for bottled gas, and die castings for lawn mowers. In addition, the company furnishes the power for the lines of the rural electrification association serving all of Lyon County and one-half of Clay and Osceola counties. The total generating capacity at all four plants is 10,860 hp.—4870 at Spirit Lake, 3240 at Peterson, 1500 at George, and 1250 at Sibley. All the units are driven by diesel engines. The company has 159 miles of transmission lines carrying current of more then 6900 volts and 450 miles for lesser voltages.

The Peterson station was constructed about 50 years ago as a steam-generating plant. When acquired by the newly organized Northwestern Company in 1925, it was powered by two steam boilers and a turbine. The steam equipment was replaced shortly thereafter by a diesel engine, and the station has been on a diesel basis ever since. Immediately before the fire it had four engine-generator sets with a total capacity of 2800 hp. Only one of these withstood the fire sufficiently to permit reconditioning, even though its generator and exciter were a total loss. The engine had been installed in the Spring of 1947.

After the fire, summer weather and intercommunity coöperation combined enabled the Peterson plant to go into



PACKAGED POWER

To help in the emergency, city officials of Spencer, Iowa, 26 miles away, permitted Northwestern to take over a 600-hp., 400-kw. generating set that had not yet been placed in service. The machine was transported by truck-trailer, as shown, and consists of an Ingersoll-Rand Type S, 8-cylinder diesel engine driving an Elliott generator. Both elements are mounted on structural-steel bases that facilitated moving them as one piece. Ruins of the burned Peterson plant are seen in the background.

partial service on July 30, just 38 days after operation stopped. Inquiries directed to several diesel-engine manufacturers revealed that an Ingersoll-Rand engine and generator had been delivered a short while before to Spencer Public Utilities, a municipally owned station at Spencer, Iowa, only 26 miles from Peterson. The unit had been ordered by Spencer Utilities as a stand-by to provide power for pumping the greatly augmented volume of water required during the Clay County Fair, which is billed as "The biggest county fair in America."

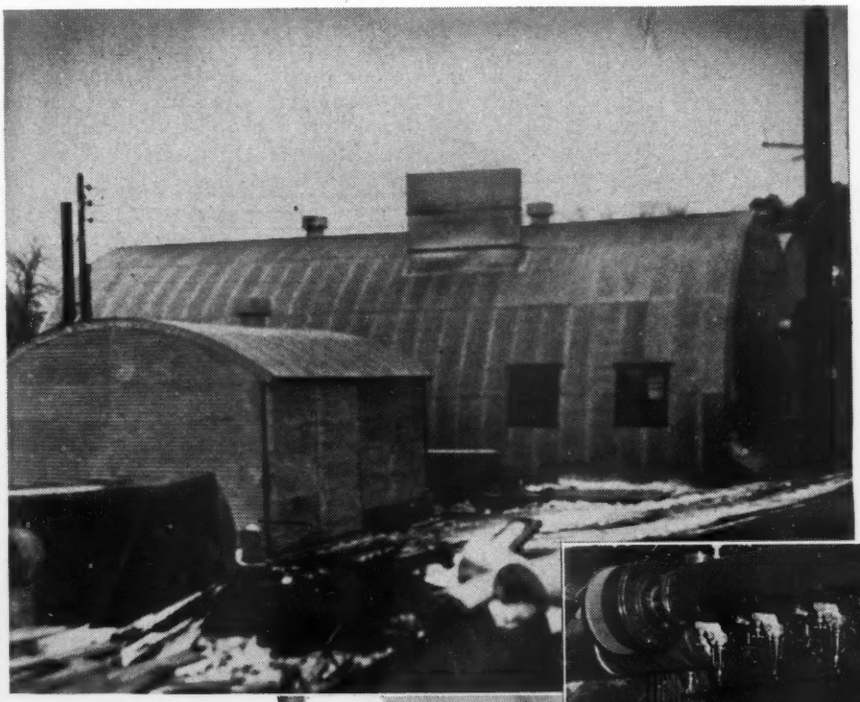
The machine had not yet been placed in service, and Spencer Utilities agreed to its diversion to Northwestern at Peterson. Need of extra power for the fair was taken care of by a 5-year interchange of power contracted in 1947 between Spencer and Northwestern. The 26-ton piece of equipment, loaded on a special heavy-duty trailer drawn by a diesel tractor, was moved from Spencer to Peterson by Marsh Brothers of Cherokee, Iowa, on July 8. The engine and generator were transported as a single unit, without the necessity of dismantling. A paved highway connects the two towns, and no difficulty was experienced during the haul, which was made in one day.

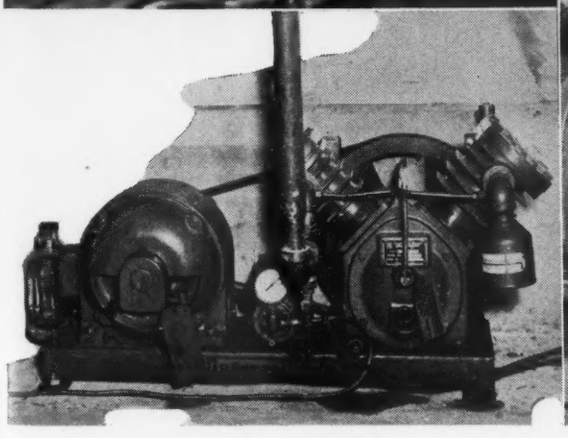
The engine is an 8-cylinder, Type S, 600-hp. unit operating at 720 rpm. and is direct connected to an Elliott 400-kw. generator. Air for starting is supplied by an Ingersoll-Rand Type 30 compressor driven by an electric motor. Installation of the machinery was begun before the structural steel-and-brick walls of the fire-gutted powerhouse had been completely dismantled. Later it was housed in a quonset-style, all-metal building 20x24 feet in size and insulated with fiber glass. After the debris had been cleared away and the engine-generators and unusable equipment had been removed, another structure of the quonset type, occupying 60x80 feet of floor space, was constructed on the site. The two buildings were erected at approximately 20 percent of the cost of conventional brick-and-steel structures of equal size.

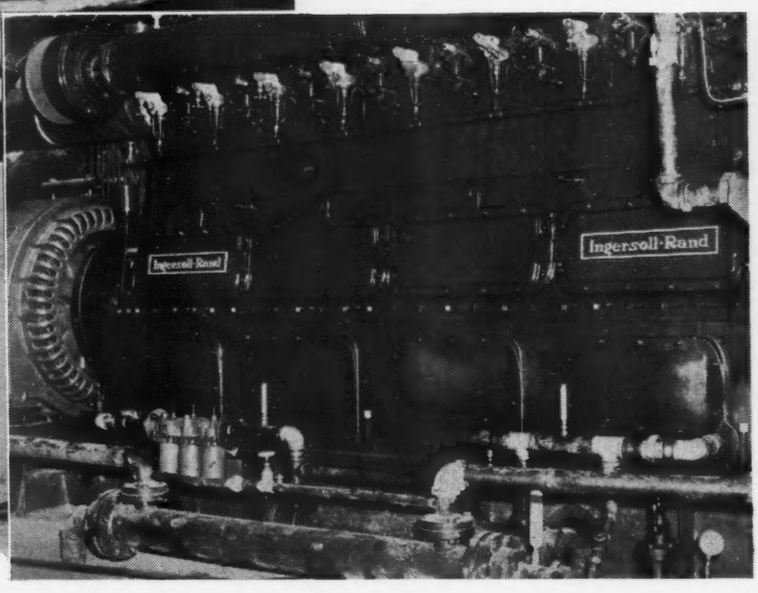
The larger building now houses a new 16-cylinder, 1440-hp. diesel engine driving a 1050-kw. generator and the 6-cylinder, 1200-hp. unit that was reconditioned following the fire and connected to a new 840-kw. generator. The first of these went into service on October 8 and the second on October 25. Thus the Peterson plant, with its capacity increased by 440 hp., was again in full operation just 125 days after the fire. The station is located on the Little Sioux River, and water for the cooling system is obtained from that source, as well as from a supplementary well. The water is clarified and softened to zero hardness.

All fuel oil for the plant is in outside storage tanks having a total capacity of 71,000 gallons. While the exact cause of the fire has not been determined, every precaution has been taken in rebuilding to prevent the ignition of inflammable materials during electrical storms. Each engine has its own underground 500-gallon fuel tank, and at no time is there more than 5 gallons inside the structures for each engine. Lubricating oil also is stored in an outside tank holding 2000 gallons, but the quantity available in the buildings is not allowed to exceed 150 gallons.

Division manager for the Northwestern Light & Power Company at Spirit Lake is L. P. LaFontaine. Louis Ammons is chief engineer at the Peterson Plant.







IN OPERATION

The first of the three diesel engine-generator units in the new plant was set up outdoors, and the small quonset-type structure in the foreground of the picture at the left was built around it. Later the larger structure was put up to house the two other units. The view below shows one side of the 600-hp. Type S diesel engine in the smaller building. At the lower left is the motor-driven, air-cooled Type 30 compressor that supplies compressed air for starting the engine.

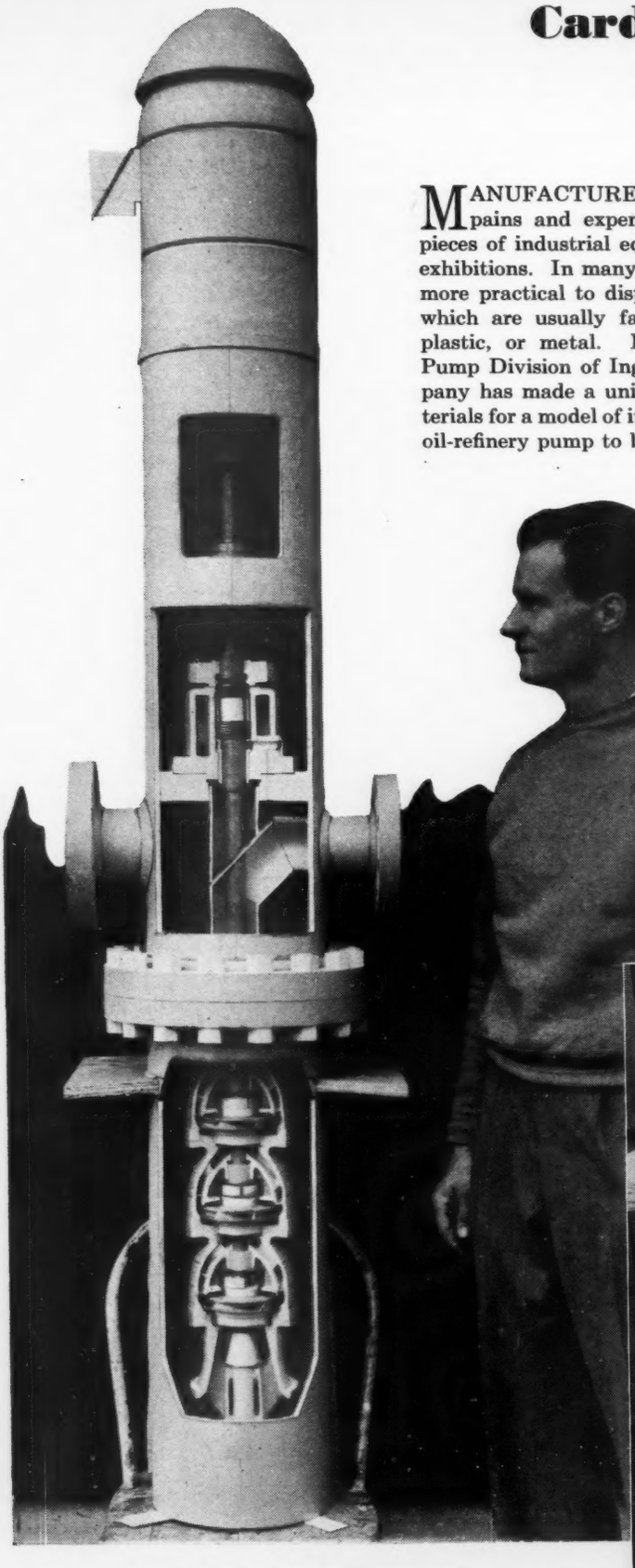
Cardboard Pump Model for Display

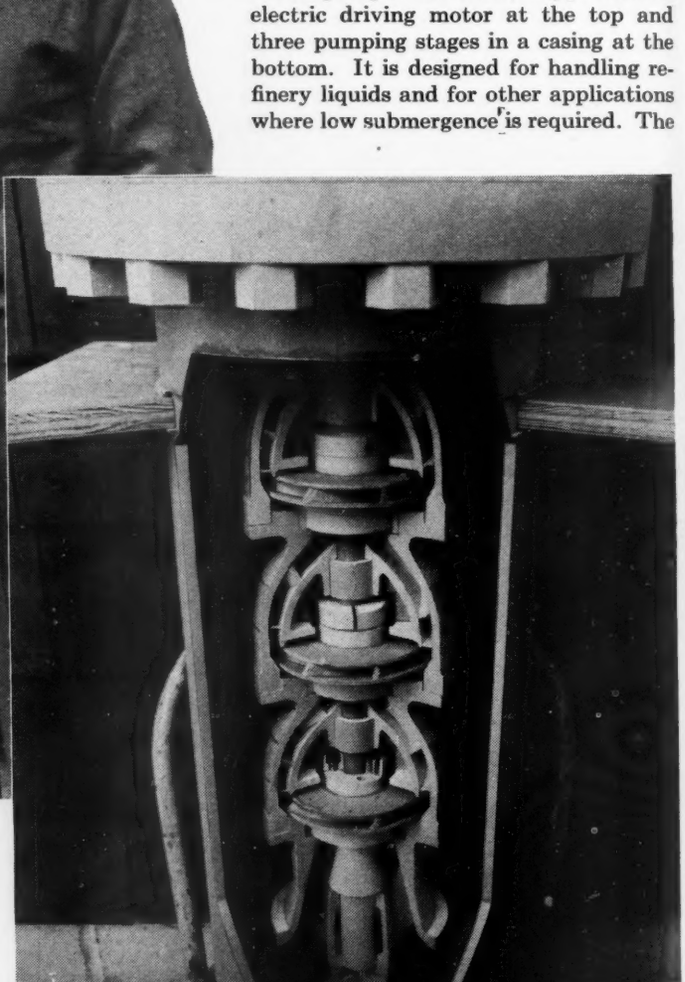
MANUFACTURERS go to great pains and expense to show large pieces of industrial equipment at trade exhibitions. In many cases it would be more practical to display scale models, which are usually fashioned of wood, plastic, or metal. But the Cameron Pump Division of Ingersoll-Rand Company has made a unique choice of materials for a model of its vertical, 3-stage, oil-refinery pump to be exhibited at the International Petroleum Exposition in Tulsa, Okla., May 15-22. Of full-scale size, 7 feet high, this model is composed almost entirely of cardboard.

There were several reasons for this choice. First, Product Models, Trenton, N. J., has proved that cardboard "mock-ups" are not only entirely feasible but also have many inherent advantages. Second, light weight is a real blessing in any industrial display. Third, the use of other materials in this model would have presented problems that were avoided by cardboard.

A model was wanted that would show all the essential details of the pump and that would look as much like the real thing as possible. Inside parts were to be exposed by appropriate cutaway sectioning; rotating parts were to be turned slowly by means of a small, hidden electric motor; and to accent the functions of the various parts they were to be given different colors.

The pump is of a vertical type with an electric driving motor at the top and three pumping stages in a casing at the bottom. It is designed for handling refinery liquids and for other applications where low submergence is required. The





MODEL AND ITS BUILDER

Morton P. Matthew standing beside the 7-foot-high, full-scale replica of an Ingersoll-Rand pump that he built almost entirely of cardboard. A graduate engineer and World War II veteran, Mr. Matthew developed what began as a hobby into a business that goes under the name of Product Models. The close view of the 3-stage pumping element at the right reveals the intricate construction and close fit of the parts. The shaft and impellers are turned slowly by a hidden motor to demonstrate how the pump operates.

entire pumping element is immersed in the fluid being pumped, and this makes it easy to obtain a positive suction head when handling products of low specific gravity. It would be difficult to accomplish this with a horizontal pump. In some cases, even the piping is placed underneath the floor line and only the motor is visible. A typical service of a unit of this type around refineries is that of pumping propane into tanks for storage under pressure.

The fluid enters through a 4-inch nozzle and fills the casing. It is pumped upward and discharges by way of a gradual bend through a 3-inch nozzle. Each pumping stage has an impeller with curved blades between converging conical surfaces. Each impeller discharges into a bowl-shaped passage with scroll-shaped diffusors that direct the flow around, upward, and back toward the center. A stuffing box, glands, mechanical seal, couplings, flanges, bearings, etc., make up the remainder of the unit.

The pump weighs 950 pounds. It would be a heavy object to ship from the factory at Phillipsburg, N. J., and back. Several men would be needed to assemble it at the exhibition, taking up both space and time, which are at a premium when preparing a display booth. Setting aside a real pump out of stock and cutting it up to show its inner workings is no small item of expense. What is more, Ingersoll-Rand wanted to show an advanced design somewhat different from any that had yet been manufactured. A model seemed to be the answer. The one made weighs only 40 pounds.

Plastic was first considered, and instead of cutaway sections the exterior was to be transparent. Such a model would have been costly, and still fairly heavy. The material also offered machining and fabricating difficulties. Wood, too, has limitations. The casings are 10¾ inches in diameter, outside, have ⅜-inch walls, and are about 3 feet long—not the easiest shape and size to turn out quickly. There is no guarantee against warping and cracking, especially in areas where walls are thin or grain direction is unfavorable. The job of whittling out 40 thin, curved, and twisted impeller blades would not tempt any woodworker.

Product Models proposed to build a pump of cardboard. In the case of this material most of the aforementioned problems do not exist, and others of a serious nature seemed unlikely. The model was ordered, and was made of cardboard with the exception of the long narrow shaft, which is of aluminum; of some thin, flat supporting plates, which are of plywood; and of a mechanical seal which is actual stock.

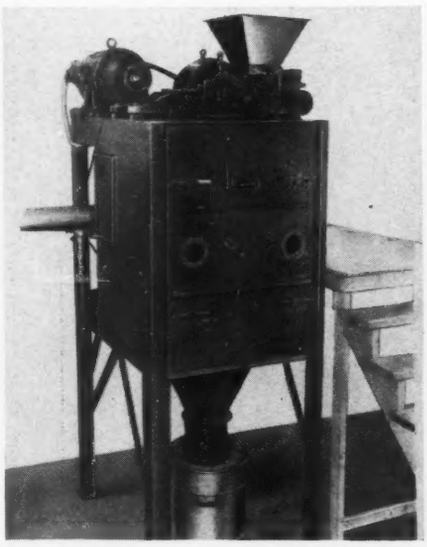
Accompanying illustrations show how successfully the idea has worked out. It is worth noting that there are four bearings in a line at the three pumping stages. The bearing housing, inner bowl, scroll blades, and outer bowl, through which each of the three upper bearings is positioned in relation to the flange mating with the succeeding stage, is an assembly of separate pieces. Even so, no special shimming or adjustment was needed to bring the bearings into alignment; the shaft fits are so close that an observer cannot readily see that there is a clearance; and the shaft turns freely in the bearings. Also of interest is the shape of the motor at the top of the mock-up. It has two surfaces with a double curvature. These were made entirely of cardboard without the aid of solid forms and in about half a day.

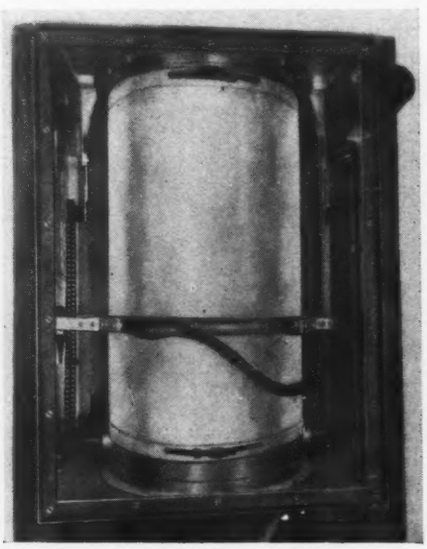
The technique of fabricating parts of cardboard has resulted in satisfactory working models of spur, bevel, helical, and worm gears in simple and in planetary reduction, of screw threads, splines, roller bearings, and turbine blades. Even a complete gas turbine has been reproduced. Sometimes the most unusual is the most practical, and the cardboard pump mock-up is a case in point. After the exhibition closes, the model is to be set up in the Cameron engineering offices at Phillipsburg.

Dust Collector with Pneumatic Cleaner for Filter Bag

WITH the introduction of its Mikro-Collector, the Pulverizing Machinery Company has entered the dust-collecting field. The unit is said to be a departure in several respects from conventional equipment of this kind and is suitable for filtering room air or for use as an auxiliary to pulverizing, processing, or materials-handling machinery. The filtering medium is in the form of a cylindrical bag of hard-pressed wool felt which, despite its thickness and the fineness of its pores, is prevented from clogging by a hollow, annular blow ring that is moved up and down by chain and sprocket drive. This ring hugs the bag and flexes it by a countercurrent of air delivered through a hose connection and escaping from a narrow slit on the inner periphery of the ring. It is claimed that cleaning by this method is so thorough that the filter is always available for service without loss in efficiency.

Either positive or negative pressure may be used to induce the air flow through the bag. In the case of the former, the dust is blown directly into the filter by means of a fan; by the more frequently employed negative pressure, the fan draws the air from the clean-air chamber between the bag and the air-tight cabinet in which it is centered. The dust-laden air is admitted through an opening in the roof of the housing, is caught in the radially directed air stream, and is swept against the inner surface of the bag. Some of the particles cling to the fabric, forming a layer of dust that is dislodged by flexing the felt, as described. The solids fall into a conical discharge hopper and the clean air can generally be recirculated. About 35 standardized single-bag units are in service, and operating records indicate filtering rates ranging from a minimum of 8 cfm. per square foot of filter surface to 30 cfm. and more. The average is 20 cfm. per square foot.





COMBINATION UNIT

At the left is a direct-discharge dust collector with a pulverizer mounted on top of it. The cabinet, made of steel or aluminum, houses the cylindrical filter and, beneath it, the positive-pressure blower that provides the air for flexing the felt bag, the exhaust fan, the driving motors for these units, and the conical discharge hopper. The other picture shows the filter with its encircling blow ring and flexible hose connection. Small and large single- and multiple-bag units are being manufactured.

Copra Gives Us Essential Oil

J. Walter Frates

AMONG the shortages created by World War II in the Western Hemisphere is edible oil derived largely from copra imported from the Philippines, Guam, and other South Pacific islands. Lack of ships cut off that source of supply and led to the building up of large stock piles of the material especially in the Philippines.

Today, to meet the great demand for edible oil, more than 45,000 tons of copra is entering the United States each month. Of this quantity, some 25,000 tons is passing through the San Francisco Bay area of California alone, and because of this fact the authorities of the Port of Oakland, which is situated on the mainland side of the bay, have taken steps to insure the rapid transfer of the material from freighter to waiting truck or railroad car. A battery of three blowers has been installed there and provides what is reported to be among the fastest and most efficient equipment of its kind on the West Coast for the unloading of bulk copra.

Copra is obtained from the fruit of the coconut palm, and palm oil and other products derived from it have been used since the days of Cleopatra for religious, civil, and personal purposes. Coconuts, when fully ripe, contain only a small quantity of milk, most of it having coagulated to form the thick, fleshy "meat" that is approximately 30 to 40 percent oil and 50 percent water. The nuts are collected, split into pieces, and dried, the meat shrinking away from the shell in the process.

The yield from 1000 nuts is 440 to 550 pounds of copra containing about 10 percent of water and 63 to 65 percent of oil when kiln dried and as much as 74 percent when dried by hot air. The material is crushed and then heated to rupture the cell walls before it is put into hydraulic presses. Two pressings are usually required to extract all the oil from a batch of copra. The crude oil is sold to refineries or to other industrial plants, while the meal that remains, either in concentrated form or mixed with other feed, is fed to dairy cattle.

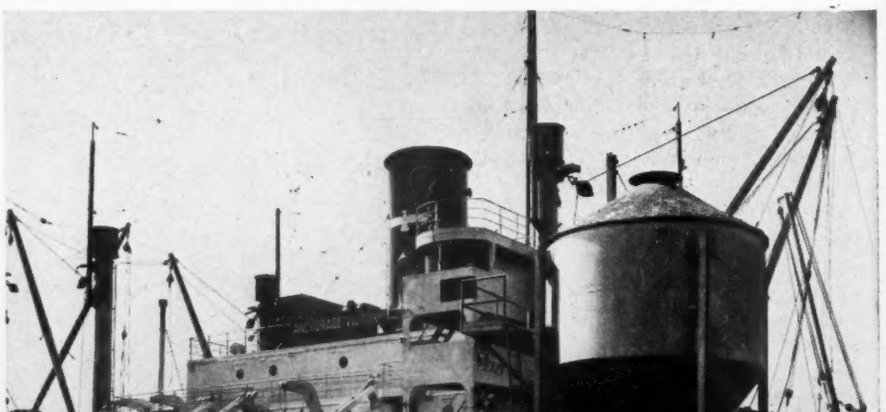
Copra enters mainly into the manufacture of margarine, mayonnaise, soap, plastics, nylon, paints, and special oils. It has but one competitor in the vegetable-oil field, and that is the babassu nut which grows wild in Brazilian jungles on a tree resembling the coconut palm. The kernel yields nearly 67 percent of oil, which is used in Brazil as a substitute for olive oil and butterfat. Because the babassu will burn when ignited with a match, it is called the Brazilian "candlenut."

Before the war began copra was unloaded in the San Francisco Bay area with the aid of blowers provided by the California Stevedoring Company, which had contracted to handle the cargo. At the end of the conflict, however, the Oakland Board of Port Commissioners decided to install equipment of its own and purchased three modern blowers for the Seventh Street Unit of the Outer Harbor Terminals. Mounted separately on movable platforms and powered by diesel engines, they are the only self-contained units on the Oakland side of the bay that are capable of serving any one of the port's terminals.

When in operation, a blower is generally stationed on the wharf next to the ship to be unloaded. A long, flexible pipe is run from the unit up over the side of the vessel and down into the hold, where men with shovels feed a steady stream of copra to the open end of the tube through which it is carried by suction to a cyclone chamber. From there it is blown through similar piping into waiting box cars, into a hopper used for loading trucks, or into a shed to await shipment. To facilitate the storage of bulk copra, the shed is provided with portable plank barricades 8 feet high. These can be shifted about readily to form bins holding quantities ranging from a few tons to a thousand and more.

Although the blowers have a rated capacity of 30 tons an hour each, the actual tonnage moved depends upon a number of factors—chiefly upon the speed with which the men in the holds feed the loose material to the suction pipes. The best performance record to date was made on November 19, 1947, when two units discharged 290 tons of copra from the *Trein Maersk* at the rate of 58 tons per hour for five hours.

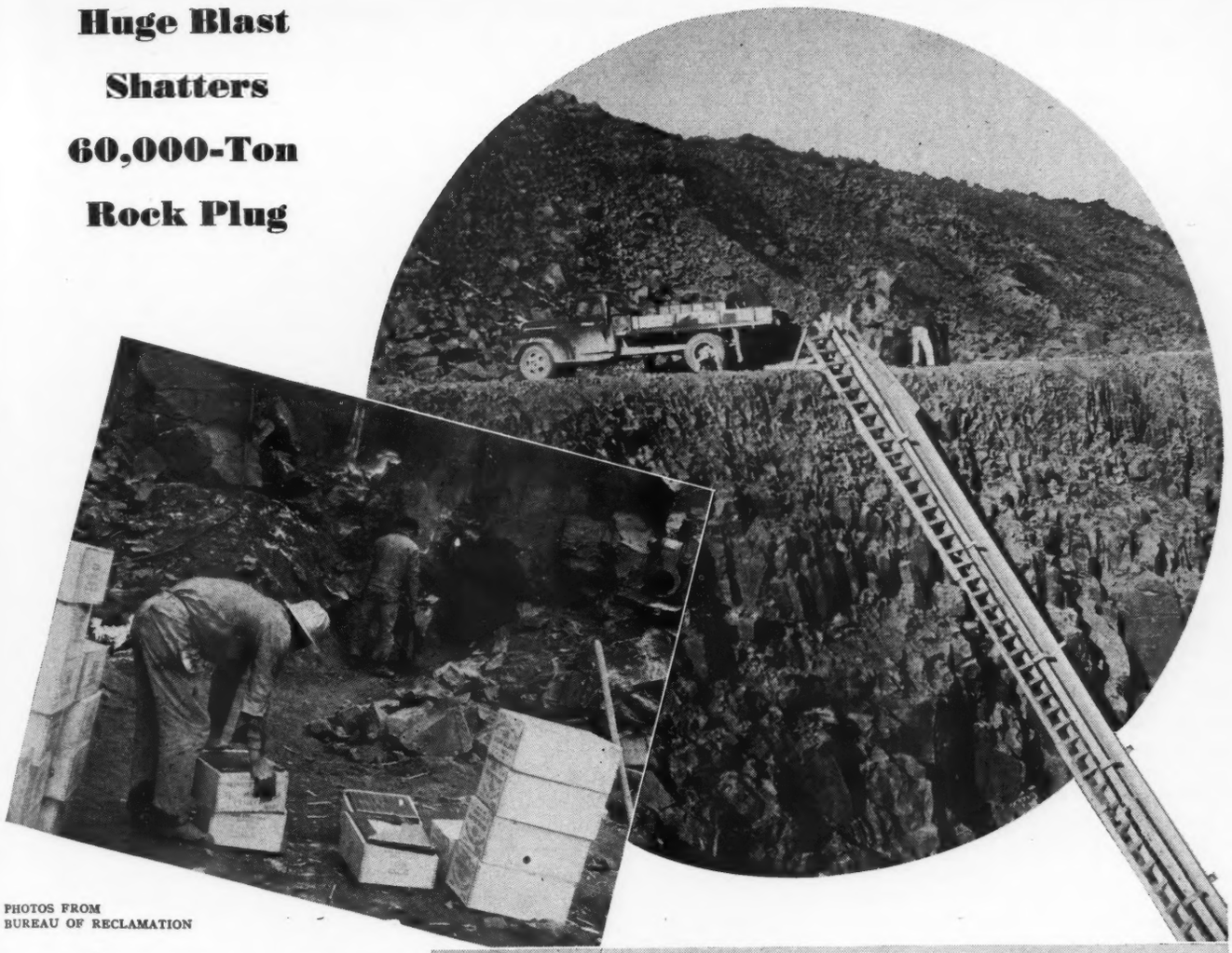
It has been suggested that the blowers be used to unload bulk sand as well as granular products that are to be processed, in which case shattering of the grain is of no consequence. But sand, others point out, is not suitable because of its abrasive character, for even copra, though an oily and waxy substance, has caused elbows in the flexible pipe and curved sections of the blower inlets to wear out through friction. Officials of the Port of Oakland, however, are not concerned about this discussion because the demand for vegetable oil is so great that it is unlikely that the equipment will handle anything but copra for some time to come.



UNLOADING COPRA IN OAKLAND

The bulk material is conveyed from the ship's hold to the hopper on the pier by means of a pneumatic-tube system. It is then loaded into trucks, one of which is seen pulling away. One of the two blowers that serve the tube is visible just above and back of the truck. Blower units and hopper are wheel-mounted so they can be moved about readily.

Huge Blast Shatters 60,000-Ton Rock Plug

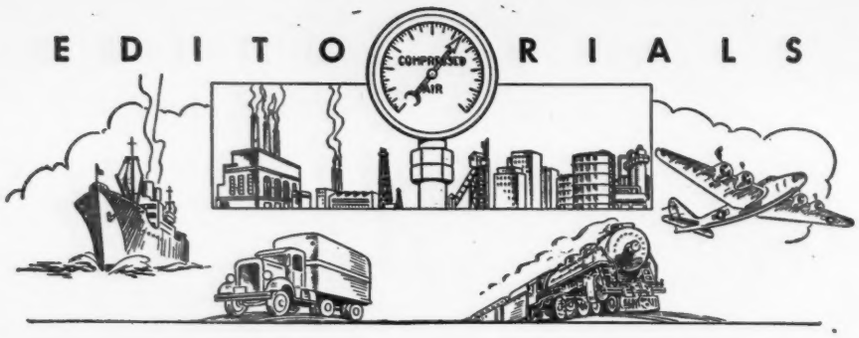


PHOTOS FROM
BUREAU OF RECLAMATION

IN EXCAVATING a section of the Main Canal of the Columbia Basin Project near Coulee City, Wash., for the U. S. Bureau of Reclamation, the contractor, J. A. Terteling & Sons, left the material in place at one point to serve as a crossover for equipment. After all but this part of the work had been completed, the "bridge" was removed. It consisted entirely of rock, weighing an estimated 60,000 tons and rising to a height of 90 feet from the bed of the channel, which is 50 feet wide at the bottom and 144 feet at the top.

The plug was blasted with 17,000 pounds of dynamite, of which 15,000 pounds was war-surplus material. A coyote hole was driven 100 feet into the base of the barrier, with four laterals branching from it and terminating in small rooms. The explosive was distributed among these openings and detonated.

Pictures show phases of the work and the result. At the top are boxes of dynamite being unloaded from a truck prior to being lowered down a chute to the canal bottom. The powder was then placed in bags and transported into the coyote hole in wheelbarrows (center). The lower view shows the blast, which broke the material much as had been expected.



HELPING UNCLE SAM

TWO proposals aimed at giving Uncle Sam something in return for his assistance to overseas nations under the European Recovery Plan seem to possess merit. One of these, put forward by W. L. Batt, industrialist and wartime government official, suggests that each of the recipient countries reimburse us with raw materials urgently needed for our national emergency stockpiles. The second recommendation is that they send us a ton of essential scrap metal for every ton of supplies and equipment we ship to them.

Mr. Batt points out that in the event of a war in the near future we would be at a "desperate disadvantage" because of shortages of such strategic materials as tin, manganese, and bauxite, the last of which is the ore from which aluminum is produced. Among the sixteen coöperating European nations and their colonies all these substances and others are found in abundance. Here, on the other hand, we have been stripped of them to the point of scarcity through the abnormal demands of two wars, together with our heavy domestic consumption and some wastefulness during the past century and a half.

The proposition regarding scrap is backed by the National Founders' Association and is being vigorously voiced to members of Congress, with the hope that some such arrangement will be embodied in the Marshall Plan. Insufficiency of scrap in the United States is obliging foundries and steel mills to use disproportionate quantities of virgin metal, with a consequent drain on irreplaceable natural resources. It is estimated that from five to ten million tons of scrap lie idle in western Germany alone.

Meanwhile, the Steel, Foundry & Scrap Industries' Committee for Expediting Iron & Steel Scrap is endeavoring to get action on a bill introduced in the United States Senate which provides for the return to industrial channels of the maximum possible tonnages of ferrous scrap and other ferrous materials that are known to be in the possession of U. S. Government agencies in substantial amounts at home and abroad. It is the committee's contention that "without a scrap program there will be continued steel shortages in the domestic economy . . . and no European recovery, which depends in the final analysis upon the availability of steel." The bill was introduced by Sen. Edward Martin of Pennsylvania and later referred to the Banking and Currency Committee of the Senate. More recently, a companion bill was introduced in the House of Representatives by Rep. James T. Patterson of Connecticut.

It was proved during World War II that the side possessing the greatest store of such resources as oil, iron, aluminum, copper, and other strategic materials eventually is the victor in an international armed conflict. Some exponents of a strong America suggested at the end of hostilities that we bring back from the fighting areas all available supplies of scrap and other essential resources and thus create huge stockpiles as insurance against future national emergencies. They argued that if these were maintained, no nation or group of nations would be likely to break the peace with us.

The latest proposals do not go that far, but carrying them out would do much to popularize the European Recovery Plan in this country. It would be comforting to know that Uncle Sam also was participating in the benefits the plan is to bestow.

●

AN AGE OF GIANTS

IN WESTERN AFRICA and some other places, open-pit mining is still carried on largely with the power of human muscles. An endless chain of natives, with each human link carrying a basket, moves on tortuous trails up from the pit and down again. The gait isn't fast, but the chain seldom stops. Each burden bearer is paid a living wage and is apparently happy. Now and then engineers with an eye to efficiency seek to replace this primitive method of transportation with modern machinery. On several occasions loading equipment and trucks have been put to work. Each time this happens the white man learns a lesson.

The natives aren't geared to running machinery, and Europeans have to be brought in. They command higher wages, don't like the climate, and usually leave as soon as their contract period expires. Some money is saved on the actual operations involved, but the natives who are displaced are still there and have to be fed and clothed. Sooner or later the machines are disposed of and the human chain starts functioning again. The lesson the white man learns is that in such an economy the human machine will, all in all, do the job more satisfactorily than one run by an engine and gears.

Things are different in the complex civilization we have built up on these shores. Ours is truly a world of machines. Men are necessary to operate them, but an increasing percentage of our technical brain power is being directed towards designing and building mechanical contrivances. As machines become completely automatic and foolproof, fewer people are required to watch over them. We are approaching the day when more persons will be engaged in planning and constructing machinery than in running it. There are good reasons for this, of course. With rising costs of labor and materials, mechanization offers an opportunity to do things faster and thus cut expenses.

This trend towards mechanization has taken a new twist in recent years, especially in the field of excavation. The current demand is not alone for more machines but also for bigger ones. The new heavy-duty rock drilling machine which was announced in our March issue serves to direct attention to this movement. It puts in large-diameter blast holes and was born of necessity created by the continually mounting cost of handling a unit volume of material. Public agencies charged with the responsibility of providing highways, airports, and numerous other works without unduly increasing the tax burden are beset with perplexing problems. So, too, are private producers of stone, iron ore, and other materials that are quarried or mined by the open-pit method. Contractors, likewise, have felt the pinch of keeping bids low enough to get business and still make a profit.

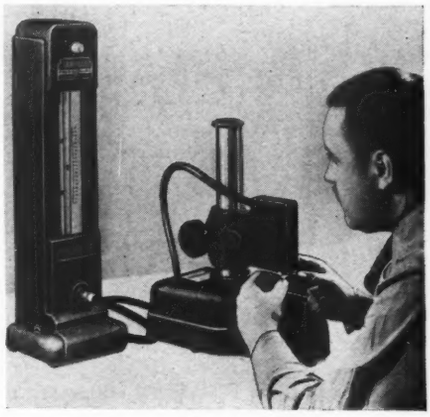
With each turn of the climbing cost spiral greater pressure has been put on machinery manufacturers to develop equipment that will help to offset the added burden. So far they have met the challenge remarkably well, but there is, inevitably, a limit to what they can accomplish. In underground mining there are space restrictions that control the size of machines. The same applies to some degree in factories. Out of doors, on the other hand, the sky is the limit. Consequently, this is an age of giant mechanical devices. If the trend continues, the feats of legendary Paul Bunyan may be surpassed.

Gauge Blocks Checked for Accuracy by Means of Air

BY A METHOD developed by The Sheffield Corporation, the length of precision gauge blocks is being checked accurately, it is claimed, without the usual danger of distortion or minute wear. There is no gauge-point contact—the only pressure exerted on the work is that of a stream of air flowing against the upper and lower surfaces. The comparator used consists of a gauging unit and of a Precisionaire—a base recording instrument having a freely moving float—with amplifications up to 40,000 to 1. Each minor graduation of the scale represents one millionth of an inch.

The gauging unit has one air jet in its diagonally serrated anvil and another in the gauging head mounted on a vertically adjustable bracket. Both jets are supplied with air from a hose connected to the Precisionaire. The gauge blocks are checked against a master calibrated set of blocks that are used in setting up the comparator and in obtaining a zero reading. The block to be checked is placed on the anvil and between the two jets. Any change of the float from zero indicates a deviation from the master, and the amount is read directly from the Precisionaire scale. If the deviation is within the allowable observation error limits set by the U. S. Bureau of Standards, the block meets all requirements.

Sheffield uses the method to check its own gauge sets, as well as those of other manufacturers. For comparison of other external dimensions of either flat or plane-surface parts of a less critical nature, the gauging unit may be used with Precisionaires of lower amplification.



COMPARATOR IN USE

The Precisionaire (left) and the gauging unit with which it is connected by a flexible hose that supplies low-pressure air to the anvil and to the column-mounted head between which the block to be checked is placed. With this set-up, Sheffield keeps the many gauge sets in continuous use throughout its plant up to standard. Each is checked three times against a zero reading, and any deviation from that reading is registered by a float moving freely in the indicating tube of the Precisionaire.

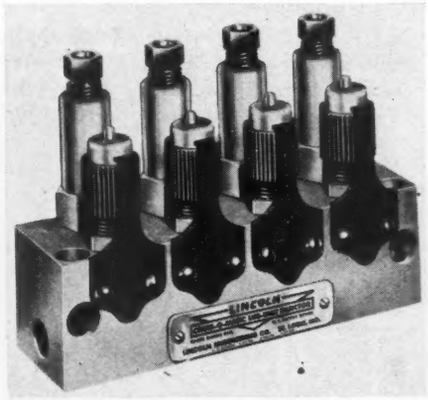
Metallizing Gun Uses Less Air

METALLIZING, a process whereby molten metal is sprayed onto surfaces by means of compressed air, is used in many industries for building up the wearing surfaces of shafts, bores, spindles and other pieces of machinery. Metal such as babbitt, bronze, carbon steel, stainless steels, or zinc is fed in wire form into a gun, melted in an oxyacetylene flame, and is then atomized and blown from the nozzle. For plants that do no need a large installation, the Metallizing Engineering Company, Inc., has added a light-duty outfit—the Type L—to its line.

According to the manufacturer, metallizing guns generally require between 25 and 30 cubic feet of air per minute in order to function efficiently. Some of this air serves to operate the turbine which feeds the wire into the flame; the remainder is used to vaporize the molten metal. It is claimed that the Type L, because of changes in turbine and nozzle design, operates on 10 cfm. and at the same time lowers the consumption of oxygen and acetylene.

A supply of 30 cubic feet of air per minute calls for a compressor driven by a motor of approximately 7½hp., while a 3-hp. compressor would suffice to furnish the air for the Type L gun, thus effecting a considerable reduction in equipment cost. The new gun weighs 4 pounds and 2 ounces, has a turbine control that needs but one adjustment for the entire range of metallizing wires, and requires no change for machine mounting.

Automatic Mass Lubricating System



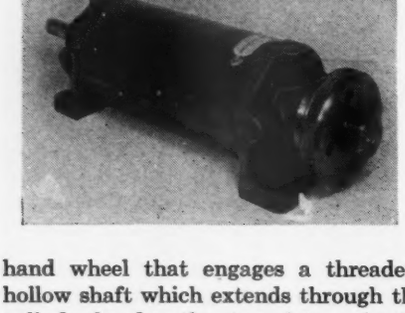
INJECTORS AND PUMP

Above is a set of four injectors which may be replaced or removed for cleaning without disturbing the base block and supply line. This assembly is 4½ inches long, 1⅜ inches wide, and 2⅞ inches high. Each injector serves one bearing. The lubricant pump (left) has an over-all height of 24½ inches. The pumping mechanism is beneath the container, which has a capacity of 60 pounds and is provided with a follower plate to facilitate priming lubricants that have a tendency to channel. Controls are mounted on the side of the housing for ease of filling.

FOR the mass lubrication of machinery, especially where mounting space is limited, Lincoln Engineering Company is offering a centralized system that dispenses either oil or grease in measured quantities. It consists essentially of a new type of injector, designated as the SL-3, and of an automatic pump powered by an air motor. The injector is of steel construction to withstand high pressure and has but two moving parts—valve stem and piston. These operate in packings of Linpak, which is a grease-and oil-resistant material that compensates for normal wear. Individual units, or groups of two, three, or four are available and are secured to base blocks drilled for either vertical or horizontal mounting. Each injector serves one bearing, to which it is connected by tubing. A single line from the pump serves the system, and the lubricant enters and leaves the injectors under line pressure. Each can be set by a knurled knob to deliver the required amount to the bearing, and a spring clip-lock prevents any change in setting through machine vibration or other cause. Maximum injector output per cycle is 0.004 ounce.

Industrial Notes

An adjustable-stroke piston is the feature of a pneumatic cylinder recently announced by Anker-Holth Manufacturing Company. In addition to the regular piston, it has a stop piston at one end by which the stroke of the piston rod can be lengthened or shortened within its limits. This is done by turning a



hand wheel that engages a threaded, hollow shaft which extends through the cylinder head to the stop piston. At the adjusting end, air is admitted to the cylinder through the hollow shaft by a flexible hose to permit movement of the shaft. The other air port is in the cover at the piston-rod end. The stop piston is provided with packing to prevent air leakage. It is claimed that the new cylinder may be used to advantage in place of several of the set-stroke type where applications require the same pressure but strokes of varying length. The device has been given the name of Airgrip and is available in bores ranging from 3 to 10 inches and with a maximum stroke of 24 inches. The model shown has a 4½-inch bore and is built for foot mounting.

According to reports received in London over the Moscow radio, Soviet scientists have succeeded, after years of research, in converting quicksands into solid foundations for buildings and in preventing its formation under existing structures. This is done by introducing two solutions under pressure. The first is water glass, which displaces the water in the sand and envelops the myriad grains. The second is calcium chloride. This reacts with the water glass, forming a compound that turns the quicksand within ten days into a compact mass that can hardly be distinguised from natural sandstone.

Fuse-ite is the trade name of a new plastic belting that originated in Switzerland and is now being distributed throughout the United States and Canada by Jules Borel & Company. It is designed for delicate work calling for light power loads and is being used extensively in the manufacture of watches. To form an endless belt, ends are brought in contact with a heated blade (300°F.) and then held together, any surface irregularities at the joint being removed by a knife or grinding wheel. The tensile strength of the connection is said to be the same as that of the belting. Other claims made for Fuse-ite are that it does not require the application of special preparations to insure smooth power transmission and that it is resistant to temperature extremes and to the deteriorating action of lubricants as well as acids up to 20 percent in strength. Flat, round, and V-belting from 0.039 to 0.59 inch in diameter is available.

Westinghouse Electric Corporation has added to its Life-Line motors a single-phase, capacitor-start, induction-run squirrel-cage motor in ratings of ¾ to 7½ hp. Of all-steel construction, the Type CAP has self-sealed, prelubricated ball bearings that will serve for five years or longer before necessitating repacking. Air openings in the lower half of the end brackets give full protection against dripping liquids. The motor is available for 25-, 50-, or 60-cycle, 110- or 220-volt

operation in a speed range of 970-3450 rpm. It is suitable for single-phase application such as driving garage compressors, pumps, and machine tools, and for refrigerating and air-conditioning units.

Levalarm is the name of a new device designed by The Reliance Gauge Column Company to set off warning signals when liquid levels in small boilers or tanks of various kinds reach predetermined high or low levels. Bells, sirens, or lights function when an electric switch is operated through the medium of a permanent magnet controlled by the rise and fall of a monel float. The switch is dust-, vapor-, and explosionproof and can be wired for a normally open or normally closed circuit. The control is suitable for use with pressures up to 250 psi.

For service where severe corrosion and high-temperature conditions are encountered, Titeflex, Inc., is making its flexible metallic tubing from monel metal and for operation in four temperature ranges. It is resistant to the action of mineral and organic acids, alkalies, and salts and can be used in both high- and low-pressure steam lines. It is available in same sizes and with same type fittings as standard brass Titeflex tubing.

For sealing shrinkage cracks between glass blocks, now a common building material, the American Fluresit Company has produced a compound that is said to insure a tight bond that expands and contracts with the glass and mortar. The sealant can be applied with a calking gun or, after thinning, with a brush, and forms a rubbery waterproof seal. It comes in white and colors.

Looking back on winter with its overabundance of snow and ice, it may be a comfort to the motorist to know that he can, in future, sand his path as he moves along. At least Jack Deagan, who devised the system to make his daily commuting safer, claims that it prevents skidding. The sand is carried in a tank in the trunk compartment and is piped just ahead of the rear wheels when the driver pushes a release. The container is provided with an agitator to loosen sand that may clog the outlet pipes.

Bulk materials such as sand, cement, lime, coal, ore, grain, etc., have a tendency to arch over in bins, hoppers, chutes, etc., or to plug them up, and to keep the stuff feeding freely it has to be jarred loose. One way of doing this is by the use of vibrators which have been especially designed for the purpose and do their work without damage to walls and equipment. The Cleveland Vibrator Company has recently announced improvements in its vertical Type F pneumatic unit. Its moving parts have been chromium plated and its base has been redesigned to insure intimate contact with the surface to which it is attached.

Blows are directed at right angles to the mounting, and the number of vibrations transmitted through the piston varies from 750 to 1525 per minute, depending upon the length of the stroke. There are five sizes ranging in over-all height from 7⅜ to 12 inches and using from 9 to 90

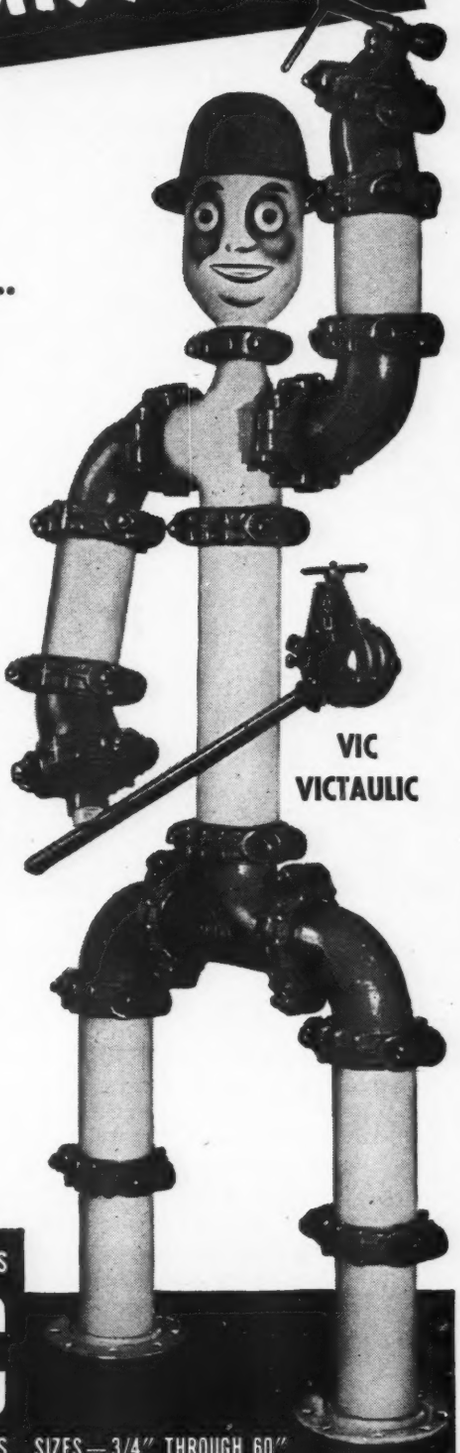
cfm. of air at 75 pounds line pressure. A horizontal Type T also is available, and both units, in addition to the application described, have numerous uses in foundries and are suitable for vibrating finished parts and mechanisms undergoing fatigue testing.

Though designed primarily for push-button control of small pneumatic presses and similar machines, Hannifin's new electric 4-way valve is said to serve equally well with the aid of limit switches and mechanical stops as an automatic control for any air-operated unit. It is

described as a packless, reciprocating, disk valve that is pilot operated and solenoid controlled. There are two types: In one, arranged for double-solenoid operation by two push buttons or limit switches, valve position is determined by energizing the proper solenoid. The other is designed for power offset operation and uses a single push button or limit switch, the valve returning to its initial position when the solenoid is de-energized. Manufacturer claims 180 and more operating cycles per minute for each type using any air pressure within the range of 25-150 psi. There are three models tapped for different inlet-cylinder and exhaust-pipe connections. Standard types are built for 115-volt, 50-60 cycle circuit.

By means of an electronic comparator announced by General Electric Company, the work of separating metallic parts that look alike but differ in composition or treatment is said to take relatively little time. The indicating instrument is mounted in a steel cabinet to which is connected an external test coil in which is placed a reference specimen for a lot of parts to be checked. After adjustments have been made to determine initial balance, and tolerances have been established, parts are inserted in coil one at a time. Coils range in diameter from ½ inch to 3 inches and leads are of sufficient length so work can

I'M YOUR MAN



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MISTER, if you want a pipe line that's *flexible* . . . has a union at every joint . . . can't blow off or pull out under pressure, vibration or sag . . . saves you money at every step —I'M YOUR MAN!

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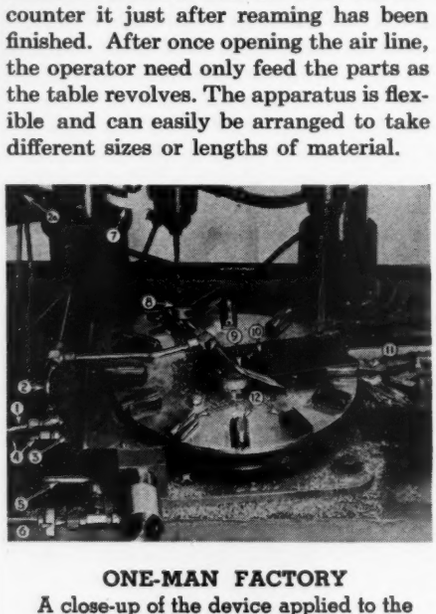
be stacked or held in most convenient position for testing. Instrument will differentiate between annealed and unannealed steel bars, magnetic and nonmagnetic materials, and sort finished metal parts varying in composition or heat treatment. It is claimed that as many as 1500 small pieces have been handled in an hour. Comparator operates on 115-volt, 60-cycle current.

Mead Specialties Company of Chicago has recently brought out an improved model in its line of work-holding devices for drill presses and similar tools. Known as the Rotary Work Feeder, the apparatus was designed for use with two drill presses to permit the drilling and reaming of small parts in one continuous operation. Compressed air is used to power the turntable, to feed the drills, and to blow away the cuttings. Fitted with clips to hold the parts being machined, the turntable locks in place at each station, the operating valves being arranged to prevent motion except when the drills are clear of the work. With the table indexed, the drill-feed valve goes into action. A pneumatic timer controls the number of revolutions per minute and, through a 2-way speed-control valve, also actuates the air cylinder which powers the turntable. Parts to be machined are put in position by hand and are ejected automatically by a cam that is mounted so that the work will encounter it just after reaming has been finished. After once opening the air line, the operator need only feed the parts as the table revolves. The apparatus is flexible and can easily be arranged to take different sizes or lengths of material.



ONE-MAN FACTORY

A close-up of the device applied to the drilling and reaming of brass valve bodies. An air line, 1, from the master valve delivers a constant supply of air through a tube, 2, to the pneumatic timer 2a. The drill-feed operating valve 3, by means of the air line 4, powers the drill-feeding cylinder 7 to move the drill and reamer downward each time the table indexes. An air line, 5, from the pneumatic timer powers the indexing cylinder through 2-way speed-control valve 6. A replaceable drill bushing, 8, guides the drill, while chip blower 9 removes the cuttings. A finished part, 11, is being ejected from a loading station, 12, by ejector cam 10.

WARMS AIR SUPPLY

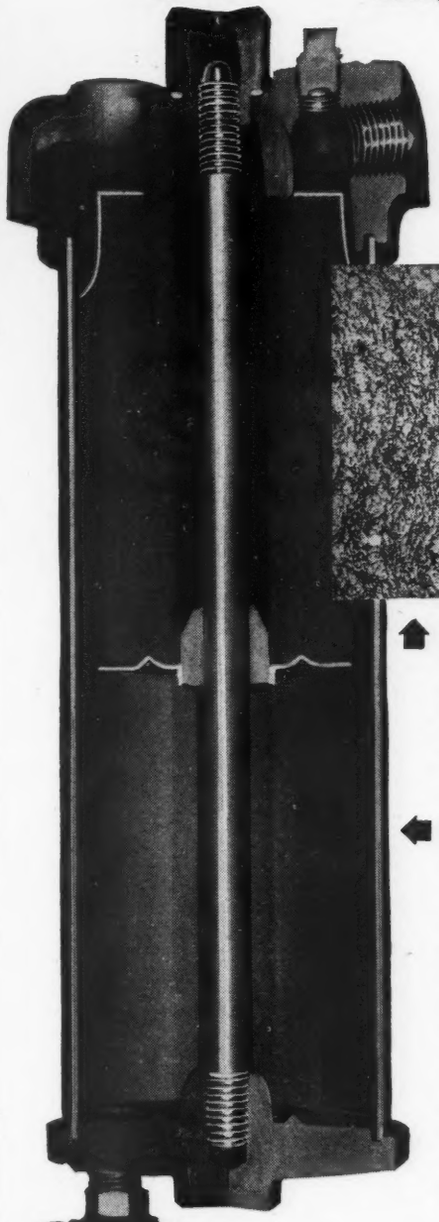
To alleviate the discomfort of breathing biting cold air through facepieces in outdoor winter temperatures or in refrigerated spaces, the Mine Safety Appliances Company offers the Airline Heater shown here. It was originally designed for wartime shipyard workers whose air supply was often chilled during delivery in exposed lines from compressors or other sources. The unit, which is attached to the wearer's belt, consists of an electric heater, heat exchanger, and thermostat, all encased in a rubber-covered cylinder 11 inches long and 2½ inches in diameter.

Applied by conventional spray, dip, or flow-coat methods, precure wax finish No. 3037 is recommended by S. C. Johnson & Son, Inc., for use on molded, extruded, or calendered rubber goods. It is said to prevent them from sticking during storage and also serves as a mold release. The compound permeates the surface, giving products a dry, satin finish, and will not build up molds through carbonizing. Its use involves no fire hazard.

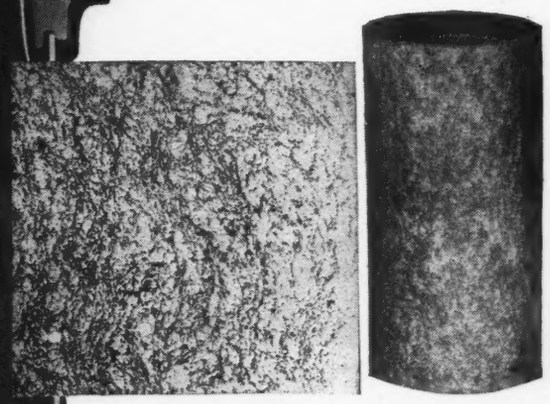
At Kure Beach, N. C., The International Nickel Company maintains a marine test basin where metal specimens are subjected to conditions they will encounter in actual service. Some are suspended from wooden racks that are lowered and raised by air hoists either to submerge them or to expose them to the attack of salt air and spray, while others are whirled through the water at high velocity. Panels are partly immersed to determine how they will resist corrosion, whether they will retard the growth of barnacles and other aquatic life, etc. To arrive at the answers may take but a few months, but sometimes years elapse before the investigators know which one of a series of metals and alloys is best suited for a given job, the purpose for which the basin was designed.

Dry Air

from the new filter with the longer-lasting cartridge



Air passing into MICRO-KLEAN FILTER first hits the baffle; any moisture not deflected, enters . . .



MICRO-KLEAN fibre cartridge where it must make hundreds of sharp turns through minute interstices, impinging on fibres.

Longer cartridge life is due to double dirt-collecting capacity and resinous impregnation which prevents wicking or channeling.

Moisture then drains from *non-wicking* fibres into extra-large collection chamber, equipped with petcock drain.

Standard Micro-Klean models handle volumes up to 80 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc. For more information, attach coupon to your letterhead.

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Industrial Literature

A series of folders describing the Hays line of strainers, measuring valves, and control valves for water, steam, and gas lines can be obtained from Hays Manufacturing Company, Erie, Pa.

Buyers and users of iron castings may secure analytical data on the characteristics and properties of process cast iron by writing for Bulletin 1115 distributed by McNally Pittsburg Foundries, Inc., Pittsburg, Kans.

Bulletin No. 32 of Eastern Machine Screw Corporation, New Haven 6, Conn., contains information that is helpful in selecting the proper die head for each threading application. Copies will be sent upon request.

Graphitic-iron piston rings for compressors and diesel engines are described in a 36-page catalogue offered by C. Lee Cook Manufacturing Company, 76 Beaver Street, New York 5, N.Y. Engineering data in the form of specifications, tables, and diagrams are included.

Raybestos-Manhattan, Inc., Passaic, N.J., has issued the sixth edition of a condensed catalogue on industrial rubber products. Among those described are transmission and conveyor belting, V-belts, hose, molded goods, rubber-roll coverings, tank linings, and abrasive wheels.

A 12-page booklet dealing with resin adhesives may be obtained from American Cyanamid Company, 30 Rockefeller Plaza, New York, N. Y. The brochure describes the company's products, illustrates their range of applications, and lists the advantages to be gained by their use.

Pipe and stud extractors built by Reps Tool Company, Inc., 94 Allyn Street, Hartford 3, Conn., are described and illustrated in a folder that will be sent upon request. The equipment is built to extract broken pieces of pipe up to 2 inches in diameter, as well as studs, screws, and bolts up to $3\frac{1}{2}$ inches in diameter.

Form P-478, obtainable upon request, describes the electro-hydraulic tensile-strength testing machine produced by Thwing-Albert Instrument Company, Penn Street and Pulaski Avenue, Philadelphia 44, Pa. The instrument is made in several sizes ranging in capacity from 1 to 1100 pounds.

Kaukauna Machine Corporation, Kaukauna, Wis., will send, upon request, descriptive literature covering the firm's line of portable drilling and tapping machines. Six models are made for drilling, tapping, or spot-facing angular, vertical, or horizontal surfaces of castings and weldments.

Uses of Neoprene such as making hose for underground electric cables, binding for flexible grinding wheels, vibration absorbers, and coatings for wire rope are discussed in a recent issue of *Neoprene News*, copies of which may be obtained from E. I. Du Pont De Nemours & Company, Inc., Wilmington, Del.

Giddings & Lewis Machine Tool Company, Fond du Lac, Wis., has published a 266-page handbook on the subject of horizontal boring, drilling, and milling machines. Its 30 chapters are arranged in sections covering machine fundamentals, basic operations, and working procedures, and more than 325 illustrations help to explain the types of boring tools and the methods of supporting, aligning, adjusting, and operating them. The binding is of the loose-leaf type, and the plan is to mail data sheets on the latest developments in machining techniques to each book owner without charge. The price of the handbook is $5.00.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., has released a bulletin, Form 4065-A, describing its J-10 Utility Jackhamer, a lightweight rock drill designed for general work in the building, plumbing, and construction fields. A copy may be obtained from the company's main office or any of its branches.

A 52-page bulletin illustrating and describing its line of disk-type valves has been released by R-S Products Corporation. Designed to give information of practical value to users in selecting valves for industrial processes, the bulletin may be obtained by writing to the company at Wayne Junction, Philadelphia 44, Pa.

Mine Safety Appliances Company, Pittsburgh 8, Pa., will send, to anyone interested, information on the new carbon-monoxide testing instrument which the firm has developed from a model intended for war use. Applicable wherever there is need of a carbon-monoxide survey, the instrument contains an improved chemical that is said to detect the presence of the noxious gas in amounts of 0.001 to 0.1 percent by volume in air.

Two booklets on the subject of insulating firebrick and refractory cements have been issued by Armstrong Cork Company, Lancaster, Pa. They contain descriptions of the various types manufactured by the company and typical applications. Included are chapters on the physical properties of firebrick, as well as charts giving heat loss and heat storage at various furnace temperatures. Copies will be sent by the company upon request.

POPEYE by TOM SIMS & BILL ZABOLY
OH, ME POOR ACHIN' BACK!
HOW TO LIFT
BEND YOUR LEGS— NOT YOUR BACK—
SPINACH ALONE AIN'T ENOUGH, POPEYE, YOU GOTTA BEND YOUR LEGS!
TOM SIMS & BILL ZABOLY
THE COMIC WEEKLY

COMICS PROMOTE SAFETY

Posters bearing cartoons such as this one, featuring characters from eight leading American comic strips, are offered free by the National Safety Council. The artists are contributing their services to make this possible. A catalogue listing the posters available may be obtained from the Council, 20 North Wacker Drive, Chicago 6, Ill.